DRAFT

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TEAM CHARACTERISTIC 750*X*
VHF *DIGITAL* RADIO

Prepared by the FAA 750X Team

This document is based on ARINC Characteristic 750-3, with Draft 3 of Supplement 4 to 750-3. In accordance with AEEC document conventions, text changed or added by the 750X Team is identified by ***bold, italic*** typeface.

Several details remain to be cleaned up in this version. It is expected that the next released version will be sufficiently mature to serve as a Draft Strawman for work toward an edition of ARINC Characteristic 750 incorporating VDL Mode 3.

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FOREWORD

An ARINC Characteristic has a twofold purpose, which is:

(1) To indicate to the prospective manufacturers of airline electronic equipment the considered opinion of the airline technical people, coordinated on an industry basis, concerning requisites of new equipment, and

(2) To channel new equipment designs in a direction which can result in the maximum possible standardization of those physical and electrical characteristics which influence interchangeability of equipment without seriously hampering engineering initiative.

One test of how gracefully a VDL Mode 3 (VDLM3) implementation can be integrated in ARINC 750 equipment is to examine the changes made to existing material in its descriptive Characteristic. In this "Team Characteristic 750X", the format, architecture, interfaces, form, fit and previous functions of the baseline ARINC 750-3 document have been retained. Technical and organizational changes have been necessary in a few instances, for clarification of the multiple modality. In other instances, the opportunity was taken to update existing ARINC 750-3 material, reflecting more recent EUROCAE, ICAO and RTCA documentation.

The content and style of some new VDLM3 material is uncharacteristically generous for an AEEC document, in explication of the workings and features of the VDLM3 system as related to functions required in implementation of the avionics. As numerous operational aspects of the VDLM3 system are new, it is believed that the presence of such material will be useful to the reader, particularly in the initial review phases. Such material also addresses the avionics architectural issues that have been identified in AEEC SAI Subcommittee meetings, and which would otherwise not be addressed (e.g., in SARPs, MASPS or MOPS). Consequently, the decision was made to keep most such material in place. It will be a task of an AEEC development project for 750X not only to discuss the new material and the changes to existing material, but also to provide guidance for the final document's style in these instances.

The baseline for this document is ARINC Characteristic 750-3, in which the current Draft 3 of Supplement 4 has been merged.

IAW AEEC practices, additive changes are indicated by ***bold italic typeface***. Deletions are not identified, except for numbered paragraphs whose headers are marked as "Reserved" (some such instances have been introduced via prior Supplements). To facilitate the development and review process of this document, conventional and "clean" formatting has been maintained in Microsoft Word. However, the formatting anticipates its eventual layout in ARINC/AEEC document style.

Contributing Members of the FAA 750X Team

Brad Baker	Rockwell Collins
Charlie Bibb	Gables Engineering
Dean Boston	Avidyne
Pedro Carabeo-Nieva	Gables Engineering
Geoff Chisholm	FAA/AND-360
Andy Colon	FAA/WJHTC
Bruce Eckstein	FAA/AND-300
Rick Finale	Gables Engineering
Abe Jaafar	Delta Air Lines
Ti-Jeun Kao	MITRE/CAASD
Al Malaga	Honeywell
Rob Morgenstern	MITRE/CAASD
Mike Murphy	ATNSI
Tom Mustach	Boeing
Lisa Negron	Gables Engineering
Claude Pichavant	Airbus
Andy Pickens	AvCom/ATNSI/AND-360
Austin Snively	ALS Consulting/ATNSI
Shawn Stokes	ATNSI
Rob Strain	MITRE/CAASD
Ben White	B. White Assoc./AND-360
Warren Wilson	MITRE

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1 INTRODUCTION

1.1 Purpose of this Document

This document describes ***radio equipment capable of providing digital as well as analog voice communications, and digital data communications, in multiple domains. As a digital data radio, the equipment is*** one of the airborne components defined in ARINC Specification 631, "VHF Digital Link Implementation Provisions". The intent of this document is to provide general and specific design guidance for the development and installation of the airborne equipment. As such, this guidance covers the desired operational capability of the system and the standards necessary to achieve interchangeability of the hardware. The VHF ***Digital*** Radio (VDR) has various modes of operation which are described more fully in Chapter 3.

Equipment manufacturers should note that this document aims to encourage them to produce maintenance-free, high performance equipment. They are at liberty to accomplish this by the use of design techniques they consider to be the most appropriate. Their airline customers are more interested in the end result than in the means to achieve it.

1.2 Airborne Subsystem Configurations

This document assumes that the airborne components implementing ***a system with ARINC 716 compatible voice and data,*** VDL Mode 2 ***data, and/or VDL Mode 3 integrated voice and data*** are arranged as shown in Attachment 1 and that they function within the system operating rules outlined in ***ARINC Characteristics 716,*** ARINC Specification 631, the ICAO ATN SARPs and VDL SARPs.

The VDR has ***three*** basic domains of operations***, which can be selected by the crew:***

- ***as an analog voice-only transceiver via double-sideband AM voice (716 voice mode);***
- ***as a data-only transceiver via ACARS Mode 0 (716 data mode), or ACARS Mode A or VDL Mode 2 (750 data modes); and***
- ***as a simultaneous voice and data transceiver via VDL Mode 3.***

In analog voice mode, the VDR is a classic VHF voice transceiver with a radio control interface. In VDL Mode 3 operation, the VDR supports digitally multiplexed user channels providing simultaneous, independent voice and data services on a single VHF frequency.

Depending on the selected ***domain and data*** mode, the VDR performs transceiver, modem, and/or link layer functionality. ***In VDL Mode 2 and VDL Mode 3 data modes***, the VDR is a link layer bridge for the VHF subnetwork. In ***the*** ACARS ***data m***odes, the VDR ***either acts as*** a simple transceiver with an analog interface to an external MSK modem contained in a MU (Mode 0) ***(see ARINC 716)***, or ***operates with an internal*** MSK modem ***which provides a digital CMU interface(Mode A), described herein***. Detailed background of ACARS can be found in ARINC Specifications 618, 619, and 620.

As a ***data*** bridge, the VDR ***operating in VDL Mode 2 or VDL Mode 3*** is an integral part of ATN ***subnetwork*** communications protocol suite. Detailed background of ATN can be found in ARINC Specification 631, ICAO VDL SARPs, and the ICAO ATN SARPs ***and associated manuals.***

1 INTRODUCTION (cont'd)

The VDR will interoperate ***with an antenna having vertical polarization and omnidirectional azimuth radiation pattern (see ARINC 716); and, depending on the selected domain and mode*** with a Communications Management Unit (CMU) Mark-2 (see ARINC Characteristics 758), a Management Unit (MU) (see ARINC Characteristics 597; ARINC Characteristics 724, ARINC Characteristics 724B, ARINC Specification 618).

COMMENT***ARY***

Throughout this document the nomenclature for the ACARS management unit is identified as MU. The nomenclature for the communications management unit Mark-2 is identified as CMU. ***When either can be used for the function or mode under discussion, the nomenclature [C]MU is used.***

1.2.1 Analog Voice Domain

When operating in the analog voice domain, the intended function of the VDR is to provide a voice communications capability between the cockpit and other compatible units, either on the ground or in the air. The pilot has control over the frequency of operation using a control panel or other compatible device. The pilot also has control of the voice transmission of the VDR via keying of the radio using the PTT microphone switch. DSB-AM voice is the only modulation in the analog voice domain. Details regarding analog voice can be found in ARINC Characteristic 716.

1.2.2 Data-Only Domain

When operating in the data-only domain, the primary intended function of the VDR is to provide a data communication capability between the aircraft system and other compatible units on the ground. The pilot, however, has no direct control over the frequency of operation; tuning is controlled as part of the data communications protocol in use at the time. The pilot also has no control of the data transmission and reception of the VDR; which too is controlled by the communication protocols and procedures in use. ACARS Mode 0, ACARS Mode A and VDL Mode 2 are the three modes of the data-only domain.

As a VDL Mode 2 bridge, the VDR is an integral part of the VDL Mode 2/ATN communications protocol suite. Detailed background of VDL Mode 2/ATN can be found in ARINC Specification 631, ICAO VDL SARPs, ICAO ATN SARPs and their associated manuals.

As an ACARS Mode A bridge with an internal modem, the VDR converts between digital data and RF waveform. As an ACARS Mode 0 bridge using an external modem, the VDR converts between an MSK baseband and RF waveform signals. Detailed descriptions of ACARS can be found in ARINC Specifications 618, 619, and 620.

1.2.3 Integrated Voice and Data Domain

When operating in the VDL Mode 3 integrated voice and data domain, the VDR provides functionally simultaneous and independent voice and data communications between the aircraft system and other compatible units on the ground (air-air communications is available for voice

only). VDL Mode 3 data provides both point-to-point data communications between the aircraft and ground and one-way data broadcast from the ground to the aircraft. Unlike the 716 voice modes used in the analog voice domain, VDL Mode 3 voice uses digital voice transmission techniques. As in the analog voice domain, the pilot has control over the frequency of operation using an RTP or other compatible device. In VDL Mode 3, the data channel(s) for a particular frequency is interlocked with the chosen voice channel and cannot be independently selected. The control of the data functionality of the VDR is handled through the aircraft and ground system MAC sub-layers and link management entities with CMU coordination.

1.3 Interchangeability

1.3.1 General

One of the primary functions of an ARINC Equipment Characteristic is to designate, in addition to certain performance parameters, the interchangeability in an aircraft of equipment produced by various manufacturers. The manufacturer is referred to ARINC Report 607, "Design Guidance for Avionic Equipment", for definitions of terms and general requirements for the airline industry for interchangeability. As explained in that report, the degree of interchangeability considered necessary and attainable for each particular system is specified in the pertinent ARINC Equipment Characteristic for that system.

1.3.2 Interchangeability Required for the ARINC 750 VHF Data Radio

Unit interchangeability is required for the VDR regardless of manufacturing source. In defining the equipment described in this characteristic, the air transport industry has chosen to depart from its previous data link standards. In order to achieve the full benefit of the economies offered by these changes, the industry desires that any provisions for backwards compatibility with VHF Communications equipment described by ARINC 716 be provided as basic provisions. The ARINC 750 radio is pin- and function-compatible with the ARINC 716 radio.

COMMENTARY

Exceptions to this are that the ARINC 750 radio has a maximum transmission cutoff enable function as described in Section 4.2.3.3 and additional ATE/BITE functionality as described in Sections 6 & 7. The cutoff function was added to be compliant with RTCA DO-207 and proposed TSO C-128. When this function is inhibited the ARINC 750 radio behaves just like a radio designed to ARINC Characteristic 716 or earlier, with the added benefit of enhanced ATE/BITE functionality.

1.4 Regulatory Approval

The equipment should meet all applicable regulatory requirements. Manufacturers are urged to obtain all necessary information for such regulatory approval. This information is not contained in this characteristic, nor is it available from ARINC.

1.5 Relationship to ICAO Documents

The basic signal-in-space definitions such as the VDR modulation for D8PSK as well as the Channel Sense and Transmitter-Receiver Interaction Performance standards are defined in the International

1 INTRODUCTION (cont'd)

Civil Aviation Organization (ICAO) Standards and Recommended Practices (SARPs) for VHF Digital Link (VDL) ***and its associated Manuals of Technical Specifications and Manuals on Implementation Aspects***. The ICAO ***Manuals of Technical Specifications*** for VDL also define the basic protocol suite***s***. Additional interoperability information needed by the air transport industry is contained in ARINC Specification 631, "VHF Digital Link ***Mode 2*** Implementation Provisions" ***and "Specification 63Z", "VHF Digital Link Mode 3 Implementation Provisions***.

COMMENTARY

A copy of the ICAO VDL SARPS and associated Guidance Material may be obtained upon request to the Secretariat of the ICAO Aeronautical Mobile Communications Panel (AMCP) by writing to:

ICAO
Air Navigation Bureau (ANB)
999 University Street
Montreal, Quebec, Canada H3C 5H7

1.6 Relationship to Other Documents

See Appendix C, Bibliography, for the relationship of this Characteristic to other documents.

2 INTERCHANGEABILITY STANDARDS

2.1 Introduction

This Section sets forth the specific form factor, mounting provisions, interwiring, input and output interfaces and power supply characteristics desired for the VHF Digital Radio.

Manufacturers should note that although this Characteristic does not preclude the use of different form factors and interwiring features, the practical problem of redesigning a standard aircraft installation to accommodate some special system could very well make the use of that other design prohibitively expensive for the customer. They should recognize, therefore, the practical advantages of developing equipment in accordance with the standards set forth in this document.

2.2 Form Factors, Antenna Considerations, Connectors & Index Pin Coding

2.2.1 VHF Digital Radio (VDR)

The VDR should comply with the dimensional standards in ARINC Specification 600, "Air Transport Avionics Equipment Interfaces (NIC Phase 1)", for the 3 MCU form factor. The VDR should also comply with ARINC 600 standards in respect of weight, racking attachments, front and rear projections and cooling.

The VDR should be provided with a low insertion force, size 1 shell ARINC 600 service connector. This connection, which should accommodate service interconnections in its middle plug (MP) insert, service and automatic test equipment interconnections in its top plug (TP) insert and coaxial and power interconnections in its bottom plug (BP) insert, should be located on the center grid of the receiver's rear panel. Index pin code 04 should be used.

The ATE interconnection insert (TP) is not to be included in the mating half of the connector installed in the aircraft as ATE interconnections are employed in the bench testing of the receiver only, except as required for the expanded functionality identified in Attachment 3. This insert should be provided with a protective cover to prevent contamination of the contacts during the time the transceiver is installed in the aircraft. Further guidance on the ATE interface can be found in Chapter 6 of this document.

2.2.2 Antennas

There are no specific form factors set forth herein for the antennas to be employed with this particular equipment as there are numerous designs presently on the market for this purpose. Designers of new antennas are encouraged to survey the present antenna mounting provisions and maintain compatibility insofar as is practicable with the present standard mountings, depending upon, of course, the particular aircraft type for which the antenna is intended and the need to minimize weight. It is recognized that for most air transport applications the antennas are integrated into the airframe design and it is, therefore, only in special installations or retrofit installations where specific "antenna units" would be needed. The design in this Characteristic is based on the use of a 0 dBi antenna. Airlines should realize that one of the factors limiting the potential throughput of the VHF communication system is the signal loss associated with the cabling between the VDR and the antenna.

2 INTERCHANGEABILITY STANDARDS (cont'd)

2.2.3 Antenna Considerations for Multiple Systems Operations

The installation designer should note that, to permit multiple VHF transceivers to be used simultaneously on the same aircraft, it is necessary to provide adequate space isolation between the antennas of each unit to ensure that the use of one transmitter does not interfere with reception on another receiver. A minimum of 50 dB of space isolation should be provided between antennas mounted on opposite sides (top and bottom) of the fuselage. A minimum of 35 dB of space isolation should be provided between antennas mounted on the same side of the fuselage. Any steps which can be taken to provide further isolation in new aircraft and antenna designs is encouraged.

2.3 Standard Interwiring

The standard interwiring to be installed for the VDR is set forth in Attachment 3. This interwiring is designed to provide the degree of interchangeability specified in Section 1.3. Manufacturers are cautioned not to rely upon special wires, cabling or shielding for use with particular units because they do not exist in the standard installation.

COMMENTARY
Why Standardize Interwiring?

The standardized interwiring is perhaps the heart of all ARINC Characteristics. It is this feature which allows the airline customer to complete his negotiation with the airframe manufacturer so that the latter can proceed with engineering and initial fabrication prior to airline commitment on a specific source of equipment. This provides the equipment manufacturer with many valuable months in which to put the final "polish" on his equipment in development.

The reader is also cautioned to give due consideration to the specific notes in Attachment 4 as they apply to the standard interwiring.

2.4 Power Circuitry

2.4.1 Primary Power Input

The VDR should be designed to use 27.5 Vdc primary power. The aircraft power supply characteristics, utilization, equipment design limitations, and general guidance material are set forth in ARINC Report 413A, "Guidance for Aircraft Electrical Power Utilization and Transient Protection".

One 10A circuit breaker should be provided in the standard installation.

2.4.2 Power Control Circuitry

There should be no master on/off power switching within the VDR. Any user desiring power on/off control for the unit should provide, through the medium of a switching function installed in the airframe, means of interrupting the primary power to the equipment. It should be noted that primary power on/off switches for the VDR are not needed in most installations, and power is wired directly to the equipment from the circuit breaker panel.

2 INTERCHANGEABILITY STANDARDS (cont'd)

2.4.3 The Common Ground

The wires designated as "Common Ground" (or as chassis ground) are used for the dc ground return to the aircraft structure and may be grounded to the chassis of the equipment if the manufacturer so desires.

In any event, they are grounded to the ship's structure. They should not be used as common returns for any circuits carrying alternating currents.

2.4.4 Internal Circuit Protection

The basic master power protection means for the VDR is to be external to the unit and utilize a standard circuit breaker rating. Within the equipment, no master power protection means is to be provided, although subdistribution circuit protection is acceptable where the set manufacturer feels this would improve the overall reliability of the equipment.

If internal protection by fuses is employed, these fuses should not be accessible when the set is installed in the aircraft radio rack but should be replaceable only when the equipment goes through the service shop.

If such subdistribution circuit protection is by means of circuit breakers, the majority prefer that these be accessible on the front panel of the equipment so that they can be reset in service.

2.5 System Functions and Signal Characteristics

A list of the system functions and signal characteristics required to ensure the desired level of interchangeability for the VDR is set forth in Chapters 4 ***through 9*** of this document.

2.6 Environmental Conditions

The VDR should be specified environmentally in terms of the requirements of RTCA Document DO-160***D***. Attachment 5 to this characteristic tabulates the relevant environmental categories.

2.7 Cooling

The VDR should be designed to accept, and airframe manufacturers should configure the installation to provide forced air cooling as defined in ARINC Specification 600. The standard installation should provide an air flow rate of 13.6 kg/hr of 40°C air and the unit should not dissipate more than an average of 75 watts of energy. The coolant air pressure drop through the equipment should be 5±3 mm at standard conditions of 1013.25 mbars. This pressure drop does not include the drop through a returning orifice when such orifice is located external to the equipment case. A loss of cooling should not cause total loss of functionality, although a partial reduction in duty cycle is acceptable.

COMMENTARY

The specified cooling air flow rate is based on an estimated average power dissipation. However, it should be noted that power dissipation during transmission is higher than the estimated average. Thus the specified air flow rate would be less that the rate recommended in ARINC Specification 600 (NIC) for the maximum dissipation.

2 INTERCHANGEABILITY STANDARDS (cont'd)

Equipment failures in aircraft due to inadequate thermal management have plagued the airlines for many years. Section 3.5 of ARINC Specification 600 ***contains a comprehensive discussion of the subject, knowledge of which can help*** prevent such problems in the future. This material ***is regarded*** as "required reading" for all potential suppliers of VDR ***equipment*** and aircraft installation.

2.8 Grounding and Bonding

The attention of equipment and airframe manufacturers is drawn to the guidance material in Section 3.2.4 of ARINC Specification 600 and Appendix 1 of ARINC Specification 404A on the subject of equipment and radio rack grounding and bonding.

2.9 Standardized Signaling

The standard electrical inputs and outputs from the systems should be in the form of a digital format or switch contact. Standards should be established exactly to assure the desired interchangeability of equipment.

Certain basic standards established herein are applicable to all signals. Unless otherwise specified, the signals should conform with the standards set forth in the subparagraphs below.

2.9.1 ARINC 429 DITS Data Bus

ARINC Specification 429 "Mark 33 Digital Information Transfer System (DITS)" is the controlling document for data word formats, refresh rates, resolutions, etc. Material in this document on these topics is included for reference purposes only. In the event of conflict between this document and ARINC Specification 429, the latter should be assumed to be correct.

2.9.2 Standard "Open"

The standard "open" signal is characterized by a resistance of 100,000 ohms or more with respect to signal common.

COMMENTARY

In many installations, a single switch is used to supply a logic input to several LRUs. One or more of these LRUs may utilize a pull-up resistor in its input circuitry. The result is that an "open" may be accompanied by the presence of +27.5 Vdc nominal. The signal could range from 12 to 36 Vdc.

2.9.3 Standard "Ground"

A standard "ground" signal may be generated by either a solid state or mechanical type switch. For mechanical switch-type circuitry a resistance of 10 ohms or less to signal common would represent the "ground" condition. Semiconductor circuitry should exhibit a voltage of 3.5 Vdc or less with respect to signal common in the "ground" condition.

2 INTERCHANGEABILITY STANDARDS (cont'd)

2.9.4 Standard "Applied Voltage" Output

The standard "applied voltage" is defined as having a nominal value of +27.5 Vdc. This voltage should be considered to be "applied" when the actual voltage under the specified load conditions exceeds 18.5 volts (+36 Vdc maximum) and should be considered to be "not applied" when the equivalent impedance to the voltage source exceeds 100,000 ohms.

2.9.5 Standard Discrete Input

A standard Discrete Input should recognize incoming signals having two possible states, "open" and "ground". The characteristics of these two states are defined in Sections 2.9.2 and 2.9.3 of this Characteristic. The maximum current flow in the "ground" state should not exceed 20 milliamperes.

The "true" condition may be represented by either of the two states (ground or open) depending on the aircraft configuration.

COMMENTARY

In the past installations there have been a number of voltage levels and resistances for Discrete states. In addition the assignments of "Valid" and "Invalid" states for the various voltage levels and resistances were sometimes interchanged, which caused additional complications. In this Characteristic a single definition of Discrete levels is being used in an attempt to "standardize" conditions for Discrete signals.

The voltage levels and resistances used are, in general, acceptable to hardware manufacturers and airlines. This definition of Discretes is also being used in the other 700-Series Characteristics, however, there are few exceptions for special conditions.

The logic sources for the Discrete Inputs to the VDR are expected to take the form of switches mounted on the airframe component (flap, landing gear, etc.) from which the input is desired. These switches either connect the Discrete Input pins on the connector to airframe dc ground or leave them open circuit as necessary to reflect the physical condition of the related components. The VDR, in each case, is expected to provide the dc signal to be switched. Typically, this is done through a pull-up resistor. The VDR input should sense the voltage on each input to determine the state (open or closed) of each associated switch.

The selection of the values of voltages (and resistances) which define the state of an input is based on the assumption that the Discrete Input utilizes a ground-seeking circuit. When the circuit senses a low resistance or a voltage of less than 3.5 Vdc, the current flow from the input signifies a "ground" state. When a voltage level between 18.5 and 36 Vdc is present or a resistance of 100,000 ohms or greater is presented at the input, little or no current should flow. The input may utilize an internal pull-up to provide for better noise immunity when a true "open" is present at the input. This type of input circuit seems to be the "favorable" among both manufacturers and users.

Because the probability is quite high that the sensors (switches) may be providing similar information to a number of users, the probability is also high that unwanted signals may be impressed on the inputs to the VDR from other equipment, especially when the switches are in the open condition. For this reason, equipment manufacturers are advised to base their logic

sensing on the "ground" state of each input. Also, both equipment and airframe suppliers are cautioned concerning the need for isolation to prevent sneak circuits from "fouling up" the logic. Typically diode isolation is used to prevent this from happening.

2.9.6 Standard Discrete Output

A standard Discrete output should exhibit two states, "open" and "ground" as defined in Sections 2.9.2 and 2.9.3. In the "open" state, provision should be made to present an output resistance of at least 100,000 ohms. In the "ground" state provision should be made to sink at least 20 milliamperes of current. Non-Standard current sinking capability may be defined.

COMMENTARY

Not all Discrete output needs can be met by the Standard Discrete output defined above. Some Discrete outputs may need to sink more current than the standard value specified above.

A Discrete output may need to source current. Discrete outputs which are to source current should utilize the standard "Applied Voltage" output defined in Section 2.9.4. These special cases are noted in the text describing each applicable Discrete output function and in the notes to interwiring.

COMMENTARY

Although defined here, Discrete outputs which provide a current output rather than a current sink are not "Standard Discrete Outputs".

2.9.7 Standard Program Pin Input

Program pins may be assigned on the VDR service connector for the purpose of identifying a specific aircraft configuration or to select (enable) optional performance. The optional operational function may be in effect at all times or only under certain conditions, such as when the aircraft is on the ground (identified by the enabling of the Air/Ground Discrete input).

COMMENTARY

Program pins may be used for a variety of purposes. Program pins enable a piece of equipment to be used over a greater number of airframe types. One way this is done is by identifying the unique characteristics of the airframe in which the unit is installed. Another is to identify the location (left, right, center) of the unit. Often program pins are used to enable (turn on) options for alternate or extended performance characteristics.

The encoding logic of the Program pin relies upon two possible states of the designated input pin. One state is an "open" as defined in Section 2.9.2 of this Characteristic. The other state is a connection (short circuit**;** i.e., 10 ohms or less) to the pin designated as the "Program Common" pin (MP10A).

COMMENTARY

Normally, the "primary" location or "usual", "common" or "standard" function is defined by the "open" logic and the optional response is programmed (encoded) by connection to Program Common.

2 INTERCHANGEABILITY STANDARDS (cont'd)

3 MODES OF OPERATION

3.1 Introduction

A fully-equipped VDR has seven modes of operation -- three for voice-only communications, three for data-only communications, and one for simultaneous voice and data communications. These modes are summarized in Table 3-0.

Functional Category	*Mode of Operation*	*Tuning*	*Xmt/Rcv Control*
Voice-Only	*DSB-AM 25 kHz*	*RTP via Label 030 words*	*PTT*
	DSB-AM 8.33 kHz	*RTP via Label 047 words*	*PTT*
	VDL Mode 3 voice only	*RTP via Label 031*	*PTT & System*
Data-Only (see Note)	*ACARS Mode 0*	*[C]MU via Label 030 words*	*[C]MU via Data Keyline*
	ACARS Mode A	*[C]MU via ACARSIP protocol*	*VDR*
	VDL Mode 2	*[C]MU via ASIP protocol*	*VDR*
Simul-taneous Voice & Data	*VDL Mode 3 voice and data*	*RTP via Label 031 words*	*PTT & System*

Note: Data operation on 8.33 kHz channels is not allowed.

Table 3-0 750X Voice and Data Modes

3.2 Description of the Modes

3.2.1 Voice-*Only* Modes

The three voice-only communications modes are:

a. Double-sideband, amplitude-modulated (DSB-AM) analog VHF voice using 25 kHz channel spacing,
b. DSB-AM analog VHF voice using 8.33 kHz channel spacing, and
c. VDL Mode 3 voice.

The first two modes, defined in ARINC Characteristic 716, ***are*** retained in this Characteristic for backward compatibility. ***Voice signals in these modes are provided via Audio Input/Output, with***

transmit and receive conditions initiated by the operator with the microphone. For both of these modes, tuning/frequency selection is made by low-speed ARINC 429 data words from an associated control panel. Label 030 tuning words are used to select 25 kHz bandwidth and Label 047 tuning words are used to select 8.33 kHz bandwidth.

The third mode is the VDL Mode 3 (VDLM3) Voice-only mode. This mode provides a digital voice communication capability on any VDLM3 system voice channel. Two levels of VDLM3 Voice services exist -- Basic Voice Service and Enhanced Voice Service. Basic Voice Service, available to all VDLM3 avionics, essentially emulates the operational "feel" of VHF DSB-AM voice and requires only an associated Radio Tuning Panel (RTP). Basic Voice also provides some VDLM3-specific features. Enhanced Voice Service, providing additional operational features, is enabled in the VDR when the service is available from the ground station and when the VDR is capable of discretely addressable operation. Essentially, this means that a valid ICAO Address is available to the VDR from the aircraft's transponder and the avionics has received a discrete network address assignment from the ground station through a log-in process. A summary of currently-defined Basic and Enhanced Voice Service features can be found in Table A8-26. VDR tuning/frequency selection for the voice-only mode is made by low-speed ARINC 429 Label 031 data words from an associated Radio Tuning Panel (see Section 8.2).

3.2.2 Data-***Only*** Mode***s***

The three data-only communications modes are:

a. ACARS Mode 0,
b. ACARS Mode A, and
c. VDL Mode 2.

ACARS Mode 0 is the basic VHF COMM-compatible data mode defined in ARINC Characteristic 716, retained by reference in this Characteristic for backward compatibility. ***In this mode, the MSK MODEM is located in an interconnected [C]MU, and the analog baseband data signals are transferred between the VDR and the [C]MU*** using two-conductor twisted pairs. Tuning data is provided ***on ARINC Label 030 words, from the [C]MU*** via a low-speed ARINC 429 data bus, while transmit/receive commands are discrete digital signals from the [C]MU.

Operation in VDL Mode A systems provides an ACARS data link capability with an interconnected CMU but locates the MODEM in the VDR. All communication between the VDR and the CMU is via a high-speed ARINC 429 bus using versions of the ARINC 429 bit-oriented protocol (BOP) for all command, control and data transfer communications. VDR tuning is controlled by the CMU using a message defined by the ACARSIP CMU/VDR Interface Protocol (see Attachment 11). Transmitter keying is controlled by the VDR, as determined by the link layer MAC.

Operation in VDL Mode 2 systems provides a bit-oriented data link and also provides support for ACARS over AVLC (AOA). Like the ACARS Mode A, all command, control and data transfer communication between the VDR and the CMU is via a high-speed ARINC 429 bus, but

is restricted to use Version 3 of the ARINC 429 BOP. VDR tuning is controlled by the CMU using a message defined in the ASIP CMU/VDR Interface Protocol (see Attachment 10). Transmitter keying is controlled by the VDR, as determined by the link layer MAC.

3.2.3 Simultaneous Voice and Data Mode

The VDLM3 system, using time division multiple access (TDMA) technology, is designed to provide support for up to four individual user groups on a given frequency. A user group comprises multiple aircraft and a ground controller in communication with each other.

VDR operation with VDLM3 provides a voice communication capability and, depending on the assigned frequency's system configuration, a simultaneous data communications capability when connected with an appropriate CMU. All system configurations include voice communication capability; there are voice-only configurations but there are no data-only configurations. One such configuration (labeled 4V) supports four independent voice user groups on a single VHF frequency. Another configuration (2V2D) supports two independent voice+data user groups on a single VHF frequency. Attachment 13 contains descriptions of the VDLM3 system configurations.

Tuning/frequency selection in VDLM3 operation is made by low-speed ARINC 429 data words from an associated Radio Tuning Panel (RTP) using ARINC Label 031 words. The tuning information provided to the VDR consists of a channel name. The channel name corresponding to one of four possible VDLM3 TDMA slots available at a particular frequency. The system configuration of the selected frequency determines the number and usage of slots and is conveyed in periodic broadcasts by the ground station on that frequency.

3.3 Mode Determination

The VDR determines its current operating mode based on the content of three state variables: CMU_STATUS, VD_STATUS, and TUNING. These variables are defined in the following subsections.

Table 3-1 summarizes the three state variables, their contents and the transition events.

3 MODES OF OPERATION (cont'd)

State Variables	Content	Transition Event
CMU_STATUS See Section 3.3.2	NULL	CMU is ABSENT or STANDBY. See Section 3.3.2
	PRIMARY	CMU becomes ACTIVE or Unsuccessful ALOHA or receives an ALO word. See Section 3.3.2.1
	BOP	(Transmit ALR) or (Received ALR and version is supported) See Section 3.3.2.2
	CMD	***Command received from CMU. See Section 3.3.2.3.***
VD_STATUS See Section 3.3.1	VOICE	Determined by ARINC 429 Label 276 or Voice/Data discrete content. See Section 3.3.1
	DATA	
TUNING See Section 3.3.6	***030***	***Determined by the presence of ARINC 429 Label 030, 031 and 047 words. See Section 3.3.6.***
	031	
	047	

Table 3-1 State Variables

Table 3-2, Mode Determination, indicates the correspondence between the operating mode and the content of the three state variables. In addition, it contains a column labeled "State" containing eight values. These values are maintained for legacy reasons and are a shorthand way of identifying a particular setting of the CMU_STATUS and VD_STATUS state variables. The State value is also used in the CMU/VDR Interface Protocol definitions contained in Attachments 10, 11, and 12 to define message precedence and validity conditions.

State	*Functional Category*	*Operating Mode*	*CMU_STATUS*	*VD_STATUS*	*TUNING*
S1	*Voice-only*	*DSB-AM 25 kHz*	*NULL*	*V*	*030*
	Voice-only	*DSB-AM 8.33 kHz*	*NULL*	*V*	*047*
	Voice-only	*Mode 3 Voice*	*NULL*	*V*	*031 (see Note 2)*
S2	*Data-only*	*ACARS Mode 0*	*NULL*	*D*	*030*
	Data-only	*ACARS Mode 0 (see Note 1)*	*NULL*	*D*	*047*
	Voice-only	*Mode 3 Voice*	*NULL*	*D*	*031 (see Note 2)*
S3	*Voice-only*	*DSB-AM 25 kHz*	*PRIMARY*	*V*	*030*
	Voice-only	*DSB-AM 8.33 kHz*	*PRIMARY*	*V*	*047*
	Voice-only	*Mode 3 Voice*	*PRIMARY*	*V*	*031 (see Note 2)*
S4	*Data-only*	*ACARS Mode 0*	*PRIMARY*	*D*	*030*
	Data-only	*ACARS Mode 0 (see Note 1)*	*PRIMARY*	*D*	*047*
	Voice-only	*Mode 3 Voice*	*PRIMARY*	*D*	*031 (see Note 2)*
S5	*Voice-only*	*DSB-AM 25kHz*	*BOP*	*V*	*030 (see Note 3)*

3 MODES OF OPERATION (cont'd)

State	*Functional Category*	*Operating Mode*	*CMU_STATUS*	*VD_STATUS*	*TUNING*
	Voice-only	*DSB-AM 8.33 kHz*	*BOP*	*V*	*047 (see Note 3)*
	Voice-only	*Mode 3 Voice*	*BOP*	*V*	*031 (see Note 2)*
S6	*Data-only*	*ACARS Mode 0*	*BOP*	*D*	*030*
	Data-only	*ACARS Mode 0 (see Note 1)*	*BOP*	*D*	*047*
	Voice-only	*Mode 3 Voice*	*BOP*	*D*	*031 (see Note 2)*
S7	*Data-only*	*Mode A, Mode 2*	*CMD*	*D*	*030/047 (see Note 5)*
	Voice & data	*Mode 3 V and D*	*CMD*	*D*	*031 (see Note 2)*
	Voice-only	*Mode 3 Voice*	*CMD (see Note 4)*	*D*	*031 (see Note 2)*
S8	*Voice & data*	*Mode 3 V and D*	*CMD*	*V*	*031 (see Note 2)*
	Voice-only	*Mode 3 Voice*	*CMD (see Note 4)*	*V*	*031 (see Note 2)*
	Voice-only	*DSB-AM 25 kHz*	*CMD (see Note 3)*	*V*	*030 (see Note 3)*
	Voice-only	*DSB-AM 8.33 kHz*	*CMD (see Note 3)*	*V*	*047 (see Note 3)*

Note*s: 1.* Data transmission on 8.33 kHz channels is not allowed*.*

2. VDLM3 is independent of the VD_STATUS indication.

3. A protocol state progression beyond PROTOCOL_NULL is not valid during DSB-AM Voice-only operating modes.

4. A protocol state progression beyond PROTOCOL_RESET is not valid during Mode 3 Voice-only operating mode.

5. This state (S7, Data-only, Mode A or Mode 2), is also valid when the tuning words are absent on the low-speed tuning bus. This allows a transition to Mode A or Mode 2 when the tuning words are absent on the bus, as may occur when the tuning select discrete is toggled, during data operation, from a port on which active tuning data exists to one which does not.

Table 3-2 Mode Determination

3.3.1 VD–STATUS State Variable

The VD_STATUS state variable can contain one of two values, VOICE or DATA

The content of the VD_STATUS state variable is determined by two external signals:

a. The ACTIVE/INACTIVE status and contents of the ARINC 429 Label 276 word received on the selected ARINC 429 tuning bus (low-speed).

b. The state of the Voice/Data Select rear connector discrete (MP7C).

3 MODES OF OPERATION (cont'd)

The following logic is used to determine the content of the VD_STATUS state variable (see Section 3.3.1.1 for the Label 276 word description and Section 3.3.1.2 for the Voice/Data Select discrete description).

1. If the VDR determines that the Label 276 status is ACTIVE, then the state of bit 11, 12, or 13 of the Label 276 word should determine the value of the VD_STATUS state variable depending on the installed position of the VDR. The state of bits 11, 12, or 13 corresponds to the selected Voice/Data state for SDI Code 1, 2, or 3, respectively, as determined by the VDR's encoded Source/Destination Identifier (SDI) setting and as indicated in Table A8-12. A bit value of 0 should assign the value VOICE to the VD_STATUS state variable. A bit value of 1 should assign the value DATA to the VD_STATUS state variable.

2. If the Label 276 status is INACTIVE ***and if the Voice/Data Select discrete input is floating (open), the VDR should set the VD_STATUS to VOICE.***

3. If the Label 276 status is INACTIVE and if the Voice/Data Select discrete input is grounded, then the VDR should set the VD_STATUS to DATA.

3.3.1.1 ARINC 429 Label 276 Word

The ARINC 429 Label 276 word may be present on the selected low-speed ARINC 429 tuning bus. If the Label 276 word is ACTIVE on the selected low-speed ARINC 429 tuning bus, then its content is used to determine the value of the VD_STATUS state variable, regardless of the setting of the Voice/Data Select discrete.

COMMENTARY

The function of ***the Label 276*** word was added to ARINC Characteristic 750 to provide aircraft manufacturers and airlines the ability to select the voice or data operation of the VDR without having the external Voice/Data select discrete ***(MP7C)*** wired in the airframe.

There are two low-speed ARINC 429 tuning bus inputs on the VDR's rear connector, Port A and Port B. Only one port is to be used at any given time for tuning input data. The active bus is determined by the setting of the VDR's Frequency Control Port A-B Select rear connector discrete (MP11D).

A Label 276 word is defined to be valid if the Sign Status Matrix (SSM) code value is NORMAL. A Label 276 word is defined to be invalid if the SSM code is not NORMAL. Based on these definitions, the following logic is used to determine the Label 276 status:

a. When the Label 276 status is INACTIVE and the VDR receives two consecutive valid Label 276 words on the selected tuning bus, such that the time between them is not greater than 500 msec, the VDR should change the Label 276 status from INACTIVE to ACTIVE.

b. When the Label 276 status is ACTIVE and if no valid Label 276 words are received in any 2.5-second interval, then the VDR should change the Label 276 status from ACTIVE to INACTIVE.

c. When the Label 276 status is ACTIVE and if the selected tuning bus changes (can be caused by pin MP11D changing from open to ground or vice versa), then the VDR should change the Label 276 status from ACTIVE to INACTIVE.

d. A VDR whose SDI setting is 0 will assume that a Label 276 word is absent, with respect to the determination of the SDI-dependent features.

COMMENTARY

The Label 276 word contains SDI-dependent commands (Voice/Data Command, Urgent Downlink Request).

3.3.1.2 Voice/Data Select Discrete Input

The Voice/Data Select discrete is the rear connector input MP7C and is used to determine the value of the VD_STATUS state variable when Label 276 is INACTIVE (see Section 3.3.1.1). When Label 276 is ACTIVE then the Voice/Data Select Discrete Input is ignored.

If this input is floating (open) and Label 276 is INACTIVE, then the VD_STATUS state variable is assigned the value VOICE. If the input is grounded and Label 276 is INACTIVE, then the VD_STATUS state variable is assigned the value DATA.

3.3.2 CMU_STATUS State Variable

The CMU_STATUS state variable can contain one of four values, NULL, PRIMARY, BOP, and CMD, that indicate the state of the high-speed ARINC 429 data transfer bus between the CMU and the VDR***, as follows:***

a. At initialization ***of the VDR***, the CMU_STATUS is set to NULL.

b. If the VDR has determined that a CMU is ***ABSENT or PRESENT/STANDBY***, then the content of the CMU_STATUS state variable is NULL. See Section 3.3.2.1.

c. If the VDR has declared a CMU to be ***PRESENT/ACTIVE,*** then the content of the CMU_STATUS state variable is PRIMARY. If an ALOHA event results in the CMU being declared "not bit oriented", then the content of the CMU_STATUS state variable is PRIMARY.

d. If the VDR has successfully negotiated a Williamsburg protocol (Version 1 or 3) with the PRIMARY CMU using the ARINC 429 ALOHA mechanism, then the content of the CMU_STATUS state variable is BOP.

e. If the VDR receives a MODE_SET.request message and responds with a MODE_SET.confirm message, as described in Section 5.3.2, then the content of the CMU_STATUS state variable is CMD. See Section 3.3.2.3 for restrictions on this state variable transition.

3 MODES OF OPERATION (cont'd)

These states are an indication of the sequential nature of the establishment of ARINC 429 data transfer between the CMU and the VDR. At system initialization the CMU_STATUS is NULL. After a CMU has been determined to be both PRESENT and ACTIVE, then the CMU_STATUS is PRIMARY. After a CMU is determined to be PRIMARY and the Williamsburg version has been negotiated then the CMU_STATUS is BOP. ***After successful exchange of the MODE_SET primitives with the CMU, the CMU_STATUS is CMD.*** The CMU_STATUS states and events are shown in the following state diagram:

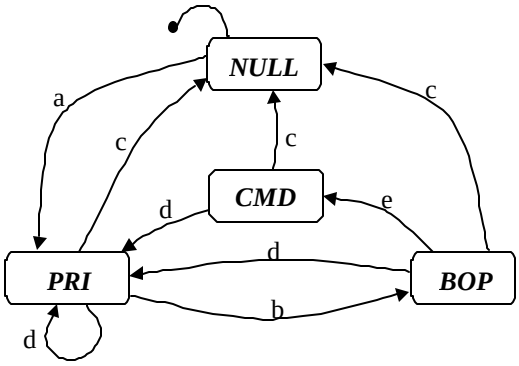


Figure 3-1 CMU_STATUS State Diagram

The events in Figure 3-1 are defined as follows:

a. CMU becomes both PRESENT and ACTIVE (declared PRIMARY). See Section 3.3.2.1.1 and 3.3.2.1.2.

b. VDR transmits or receives an ALOHA response containing a version number that is supported by the VDR. ALO/ALR handshake successful (CMU declared "bit oriented" BOP). May occur due to either a change of the supported Williamsburg version number or a change from PRIMARY to a supported version.

c. CMU becomes ABSENT or PRESENT/STANDBY. See Section 3.3.2.1.1 and 3.3.2.1.2.

d. VDR transmits or receives an ALO word. ALOHA process started ***or*** ALO/ALR handshake unsuccessful (CMU declared "not bit oriented"). May occur when a common Williamsburg version cannot be found.

e. The VDR receives a MODE_SET.request message and responds with a MODE_SET.confirm message.

COMMENTARY

ARINC 750-3 characterized the interface between the CMU and the VDR for ACARS Mode A and VDLM2. That characteristic established the precedent of providing the VDR operator the ability to force a VDR, operating in either Mode A or Mode 2, to transition to analog voice mode by manually setting the Voice/Data select in the cockpit to "Voice". In ARINC 750-3 this feature was implemented by prohibiting VD_STATUS = VOICE in State

3 MODES OF OPERATION (cont'd)

S7 (see ARINC 750-3, Table A8-17); if the VDR was in State S7 and the VD_STATUS changed from DATA to VOICE, the VDR would transition from S7 to S5.

This voice-override feature is maintained in the current version of ARINC 750; however, there is no longer a restriction that prevents a transition to CMD or the occupancy of CMD during the analog voice modes; i.e., DSB-AM 25 kHz and DSB-AM 8.33 kHz. For example, if the VDR were operating in Mode 2, CMD (State S7), and the VD_STATUS changed to VOICE, the VDR would transition to one of the AM-DSB modes in CMD (State S8) and to the PROTOCOL_NULL sub-state of CMD.

3.3.2.1 PRIMARY CMU Determination

The VDR may be connected to one or two CMUs. The VDR has a separate high-speed ARINC 429 input port for each CMU. The VDR provides one high-speed ARINC 429 output port which ***may be*** connected to both CMUs. The VDR communicates with only one CMU at a time. The VDR communicates with the CMU which the VDR has determined to be the PRIMARY CMU according to the logic herein. A CMU's presence on an ARINC 429 bus can be represented by two state variables: ABSENT/PRESENT and STANDBY/ACTIVE. The state of these two variables for both CMUs will determine which CMU is considered PRIMARY by the VDR.

3.3.2.1.1 ABSENT/PRESENT Determination

The VDR ***should*** monitor both ARINC 429 inputs for Label 270 words. If the rate of the received Label 270 word is greater than once every second and the SSM code is set to "Normal" (00_b) or "Functional Test" (10_b), then that CMU ***should be*** considered PRESENT. Else, its status is ABSENT. It ***is*** possible, and normal, for ***two*** CMUs to be PRESENT.

3.3.2.1.2 ACTIVE/STANDBY Determination

When the CMU is determined by the VDR to be PRESENT, then the VDR ***should*** determine whether the CMU is ACTIVE or STANDBY. If bit #20 (active/standby bit), of the CMU's Label 270 status word is set to "1" for five seconds, then the CMU is ACTIVE. If bit #20 of the CMU's Label 270 status word is set to "0" for five seconds, then the CMU is STANDBY. Normally only one CMU will indicate ACTIVE and only one will indicate STANDBY.

3.3.2.1.3 Primary CMU Determination Algorithm

The VDR uses the following procedure to determine the PRIMARY CMU:

a. At VDR initialization both CMUs are declared to be ABSENT.

b. If CMU1 is determined to be both PRESENT and ACTIVE, then CMU1 is declared to be PRIMARY.

c. Else, if CMU2 is determined to be both PRESENT and ACTIVE, then CMU2 is declared to be PRIMARY.

d. Else, both CMUs are declared not PRIMARY, and each CMU is periodically monitored for a change in status to ACTIVE and PRESENT.

e. If the status of the PRIMARY CMU changes, then the VDR resets to its initialization state.

Once a CMU has been declared by the VDR to be PRIMARY, the VDR uses that CMU for all communications until that CMU's ACTIVE/STANDBY or ABSENT/PRESENT status changes.

3.3.2.1.4 Primary CMU Notification

When the VDR has declared a CMU to be PRIMARY, it broadcasts this information to both CMUs. The information is conveyed periodically in the VDR's Label 270 status word in Bits 15 and 16, the Primary CMU field (see Section 5.5). This field is used to indicate which CMU the VDR considers to be PRIMARY and should be set to the SDI code contained in the Label 270 word received from the PRIMARY CMU. If neither CMU is declared to be PRIMARY, then both bits in the field should be set to "1".

3.3.2.2 BOP CMU Determination

When the CMU_STATUS state variable becomes PRIMARY then the ARINC 429 BOP version is negotiated with the CMU. There is more than one version of ARINC 429 BOP and the VDR uses the ***ALOHA*** mechanism described in ARINC 429 to determine which version to use.

When the VDR transmits or receives an ALOHA response ALR word containing a version number which is supported by the VDR then the CMU_STATUS state variable ***should be*** given the value BOP.

When the VDR transmits or receives an ALO word then the CMU_STATUS state variable ***should be*** given the value PRIMARY. This is done so that there is a state change when the VDR/CMU ***combination*** switch***es*** versions of BOP.

3.3.2.3 CMD CMU Determination

When the CMU_STATUS state variable has a value of BOP or CMD, then the CMU may initialize the CMU-VDR Interface protocol by sending a MODE_SET.request VDR Control message.

When the VDR transmits a MODE_SET.confirm in response to a valid MODE_SET.request then the CMU_STATUS state variable should be given the value CMD, and Bit 19 of the VDR's broadcast status Label 270 word should be set to 1. The format of the MODE_SET.confirm message is described in Section 5.3.2.

3 MODES OF OPERATION (cont'd)

3.3.3 ***(Reserved)***

3.3.4 ***(Reserved)***

3.3.5 ***VDR/CMU Interface*** State ***and Mode*** Transition Time

The VDR should be capable of transitioning between the states and operating modes shown in Table 3-2 within one second.

COMMENTARY

> ***The retune time for VDLM3 Voice mode excludes the time that may be needed to leave the current net after receipt of the retune command and to tune to the new channel.***

3.3.6 TUNING State Variable

The content of the TUNING state variable is referenced in Table 3-2, and it can contain one of three values -- 030, 047 or 031. This variable indicates whether tuning data is present on the selected low-speed tuning input port, and the nature of that data if present.

The ARINC Label 030 word may be present on the selected low-speed tuning bus. The purpose of this word is to convey tuning information for the DSB-AM 25 kHz Voice and ACARS Mode 0 operational modes. The format and content of the Label 030 word is shown in Table A8-18.

The ARINC Label 031 word may be present on the selected low-speed tuning bus. The purpose of this word is to convey VDLM3 frequency and channel information to the VDR. The format and content of the Label 031 word is shown in Table A8-19.

The ARINC Label 047 word may be present on the selected low-speed tuning bus. The purpose of this word is to convey tuning information for the DSB-AM 8.33 kHz Analog Voice operational mode. The format and content of the Label 047 word is shown in Table A8-20.

A tuning word, whether Label 030, 031 or 047, is defined to be VALID if its SSM code is set to "Normal" (00_b) or "Functional Test" (10_b), and the SDI field in the received tuning word matches either the VDR's SDI strapping or SDI Code "0", and the tuning information is valid for the received label.

3.3.6.1 VDR Tuning

Based on the preceding definition of a valid tuning word, the following logic should be used to determine the value of the TUNING state variable, and thus the VDR's operating frequency/channel(s):

a. At VDR initialization the value TUNING state variable should be 030. The operating frequency should be set to the default frequency.

3 MODES OF OPERATION (cont'd)

COMMENTARY

The default operating frequency for voice is 121.5 MHz. The default operating frequency for data may be established by using criteria which may differ among individual users.

b. If the VDR receives two consecutive valid Label 031 words and the time between them is not greater than 250 msec, then the value of the TUNING state variable should be 031 and the operating frequency should be derived from the content of the Label 031 word.

c. If the VDR receives two consecutive valid, Label 030 words and the time between them is not greater than 250 msec, then the value of the TUNING state variable should be 030. If the CMU/VDR Interface state is S1 through S6, or S8, then the operating frequency should be derived from the content of the 030 word. If the state is S7 then the operating frequency should be derived from the ACARSIP/ASIP PARAM.request message .

d. If the VDR receives two consecutive valid, Label 047 words and the time between them is not greater than 250 msec, then the value of the TUNING state variable should be 047. If the CMU/VDR Interface state is S1 through S6 then the operating frequency should be derived from the content of the 047 word. If the state is S7 then the operating frequency should be derived from the ACARSIP/ASIP PARAM.request message.

e. If valid tuning labels are not received or are received at intervals greater than specified above, then the TUNING state variable and operating frequency should remain unchanged.

3.4 ***(Reserved)***

3.5 ***(Reserved)***

3.6 ***VDR*** ARINC 429 Word Broadcast

When connected to a [C]MU, the VDR, in all modes of operation, should periodically transmit to the CMU the ARINC 429 words ***as*** specified in Section 5.5.

The VDR transmits the ARINC 429 broadcast words specified in Section 4.5.3, as appropriate for the current mode of operation.

3.7 Net Entry and Log-in

*****[ed. note: It is suggested consideration be given to placing this subsection in the "Reserved" Section 3.4 position, with subsections ordered by chronology of each mode.]*****

3.7.1 VDL Mode 3 Logged-in Status

To support VDLM3 Basic Voice service, the VDR needs only to complete the net initialization procedure defined in the VDL SARPs and RTCA VDL MASPS. In order to reach an operating state that supports the VDLM3 Enhanced Voice Service, the VDR must have additionally completed the VDLM3 Net Entry procedure, also defined in the VDL MASPS and SARPs.

3 MODES OF OPERATION (cont'd)

The VDR is defined to be Logged-in when both its Net Initialization and Net Entry procedures have been successfully completed. A VDR that is Logged-in has the capability to support Enhanced Voice Service. The VDR's Logged-in status can be determined by examining the bit pattern of the VDR Service Level Status field (bits 27-29) in the ARINC 429 Label 051 broadcast word (see Table A8-23). If that pattern corresponds to any of the three designations, "Enhanced Voice", "Enhanced Voice and Data Initialized", "Enhanced Voice and Data Operational", the VDR is in Logged-in status.

COMMENTARY

The VDLM3 Net Entry procedure and consequent Logged-in status are totally independent of the CMU. In addition to a Logged-in status, a VDR's support of Data Service with a ground station further requires that communication with a CMU be established via the VDLM3 Simple Interface Protocol (V3SIP), that the V3SIP protocol be in the DLS_ON state (Section 5), and that the ground station's System Configuration be one that supports simultaneous VDLM3 Voice and Data services. See Attachment 12 for details.

3.7.2 (Reserved for other modes)

*****[ed. note: The need for addressing other modes is TBD.]*****

4 INTERFACES AND PROTOCOLS *WITH* THE GROUND SYSTEM

4.1 Introduction

This Section describes the direct interface of the VDR with the VHF communications ground system(s) via the radio-frequency (RF) path (Physical Layer), and the protocols controlling the signal in space and the information it bears (Link Layer).

4.1.1 Physical Layer

The Physical Layer, its management and its attendant RF path aspects are described in Sections 4.2 through 4.4, and are characterized in terms of the distinctly different modulation methods. The modulation characteristics and air/ground protocols for each of the operational modes of the VDR are given in the following table.

Operational Mode	*RF Link Modulation*	*Air/Ground Protocols*
25 kHz Voice	*DSB-AM*	*ARINC 716*
8.33 kHz Voice	*DSB-AM*	*ARINC 716*
ACARS Mode 0	*DSB-AM/MSK*	*ARINC 618* [1]
VDLM3 Voice Only	*D8PSK*	*RTCA DO-224A*
ACARS Mode A	*DSB-AM/MSK*	*ARINC 724B, ARINC 618* [2]
VDLM2	*D8PSK*	*ARINC 631*
VDLM3 Voice and Data	*D8PSK*	*RTCA DO-224A [ARINC 63Z]* [3]

Notes:
1. ***ACARS Mode 0 is supported when the VDR is used to emulate a legacy combination of an ARINC 716 radio and a MU compliant with ARINC 618.***
2. ***ARINC Characteristics 724 and 724B refer to ARINC Specification 618 for the definition of the interface between a VHF radio in ACARS mode and a MU.***
3. ***"ARINC 63Z" is a reference to a currently non-existing document that would be the VDL Mode 3 Data equivalent of ARINC 631, which addresses only VDL Mode 2. Until such a document is undertaken and completed, reference should be made to RTCA DO-224A and RTCA DO-271A.***

Table 4-1 VDR Operational Modes

4.1.2 Link Layer

The Link Layer and its management aspects are described in Section 4.5.

4.2 Transmitter and Modulator Control

4.2.1 RF Power Output

The transmitter carrier power output measured into a 50 ohm resistive load should be 15 watts minimum and 25 watts maximum on any operating frequency when not in a 716-compatible mode.

4 INTERFACES AND PROTOCOLS *WITH* THE GROUND SYSTEM (cont'd)

COMMENTARY

The specification of 15 watts assumes a maximum cable loss to the antenna of 3.0 dB, thus providing 7.5 watts into the antenna.

4.2.2 Radio Transmitter Duty Cycle

The VDR transmitter should be capable of a long-term duty cycle of 20%.

The transmitter should be capable of the following full-power sequence of operations:

ON - 30 seconds
OFF- 1 second
ON - 30 seconds
OFF- 239 seconds.

See ARINC Specification 631 for information about maximum data transmission duration in VDL Mode 2.

COMMENTARY

The ON time values are chosen to be within the maximum continuous transmission times allowed by RTCA Document DO-207 (35 seconds), to a total transmit time of 1 minute. During a voice transmission, the OFF time is the approximate time required to release the transmitter key and re-key the transmitter following the time-out.

4.2.3 Transmitter RF Power Control

4.2.3.1 RF Output Power Level Regulation

4.2.3.1.1 Power Regulation (DSB-AM/MSK)

The DSB-AM/MSK-modulated RF output should be at least 90% of the steady state output within 50 ms after a key down condition is applied (ARINC 716, Section 3.7.10).

In any 20 millisecond period after the transmitter power ramp up time, the variation in the transmitter power should be constant within ±1 dB. This section assumes that the transmitter operates into a load with a constant VSWR not to exceed 2:1.

4.2.3.1.2 Power Regulation (D8PSK)

The transmitter ramp-up and power stabilization component of the D8PSK training sequence is defined over the time interval t = -5.5 to t = -0.5, where t = 0 is the middle of the first symbol of the synchronization sequence (see RTCA DO-271A or DO-281, Section 2.2.1.3.3 for details). The RF power should be equal to or less than -40 dB relative to the carrier (dBc) prior to time t = -5.5 and equal to or greater than 90% of the vendor's stated output power for the entire time interval between t = -3.0 and t = -0.5. Time (t) is measured in symbol periods (approximately 95.24 microseconds per symbol period).

The transmitter output power should decay at least 20 dB below the rated RF output power level within 2.5 symbol periods (approximately 238 microseconds) after the middle of the final information symbol.

COMMENTARY

In order to minimize potential interference in adjacent channels during power ramp-down, careful attention must be paid to the spectral characteristics of the RF signal during the ramp-down period.

The transmitter power leakage when the transmitter is in the "off" state should be less than -83 dBm.

4.2.3.2 RF Output Power Protection

The transmitter should not be damaged when operating into any passive load.

4.2.3.3 Transmitter Keying Protection

When the VDR is operating in a Voice mode, the ***duration of a single key-event occupancy of the channel should be controlled*** in order to be compliant with RTCA document DO-207. When an excessive ***duration, greater than 35 seconds,*** is detected the transmission ***should be*** automatically terminated. In this circumstance, an exceedance bit ***should be*** reported in the Label 270 word and subsequent transmissions ***should be*** enabled only after de-activation of the voice mode PTT discrete.

COMMENTARY

Manufacturers are reminded that maximum transmit time detection***, for operation in modes other than VDLM3,*** should be implemented as close as possible to circuitry delivering energy to the RF antenna and be independent of digital control supporting modulation hardware. This may include any or all of the following components: VSWR detector, current to the PA, and temperature of the PA.

Except in VDLM3 operation, the voice mode maximum transmission cutoff enable function may be inhibited through an analog discrete (MP2A) as described in Attachment 4.

COMMENTARY

For VDR operation in VDLM3, LME logic controls the maximum transmission duration independently of the transmitter keyline. The time-division nature of transmissions precludes application of RF-sensing techniques and also supports other system features that obviate "stuck microphone" situations. LME logic will control maximum transmission duration in both Voice and Data modes. Literal monitoring of RF or its surrogate signals is optional.

When the VDR is operating in ***a*** Data mode, the length of transmission is monitored. When an excessive ***duration*** transmission is detected transmit keying is terminated unilaterally and permanently. Control electronics are assumed to be in a failure state and should be placed in a halted condition.

COMMENTARY

Although not ***specifically*** required by RTCA DO-207, the ACARS and VDLM2 modes' maximum transmission cutoff enable functions are included to terminate a continuous transmission after a maximum of 35 seconds.

4.2.4 Tuning

The radio should be capable of tuning to its assigned channel within 100 msec of the receipt of the last bit of the command on the appropriate ARINC 429 input.

Depending on its operational mode, the VDR accepts frequency information from two sources: a radio control panel and a ***[C]***MU. The VDR's respond to tuning commands within a time that is dependent on its mode of operation (see Section 3 for mode descriptions.)

If the VDR's current mode is DSB-AM 8.33 kHz, DSB-AM 25 kHz, or ACARS Mode 0, and it is commanded to retune to one of these modes, then it should be capable of retuning within 100 msec of the receipt of two consecutive and valid tuning words whose frequency information is identical. See ARINC Characteristic 716 for details.

If the VDR's current mode is either Mode A or Mode 2, then the VDR accepts tuning information across the high speed ARINC 429 bus ***from the CMU in a PARAM.request message. The VDR's response to a PARAM.request is defined in the active CMU/VDR interface protocol (see Attachment 10 or Attachment 11, as appropriate).***

If the VDR's current mode is VDLM3, and it is commanded to retune to a different VDLM3 channel, then it should be capable of tuning to the commanded channel within 100 msec of the receipt of two consecutive, valid tuning words whose frequency information is identical and, if required, when the Leaving Net message transmission is completed. Upon completion of tuning to the new channel, the VDR should initiate beacon acquisition automatically.

COMMENTARY

See Section 3.3.6 for the definition of a valid tuning word.

4.2.5 Modulation Definition for Analog Voice ***(DSB-AM)***

Analog voice transmission, compatible with ARINC Characteristic 716, is included in the VDR for backwards compatibility ***and is accomplished through double-sideband amplitude modulation (DSB-AM)***. Radio characteristics can be found in ARINC Characteristic 716.

4.2.6 Modulation Definition for ***DSB-AM/MSK***

A MSK modulator provides ***for ACARS Mode 0 and Mode A data transmission by imposing binary minimum-phase shift keying on an otherwise conventional DSB-AM RF carrier***, as defined in ARINC Specification 618.

4.2.6.1 Training Sequence ***(DSB-AM/MSK)***

The training sequence, comprising Pre-Key and bit ambiguity resolution segments as defined in ARINC Specification 618, should be sent before each transmission on the VHF frequency. A SYN SYN (16_h 16_h) follows the bit ambiguity. The transmitter ramp-up allowance for prekey is 2 msec.

4.2.7 Modulation Definition for D8PSK

A D8PSK modulator provides Differential Eight-Phase-Shift-Keyed ***digital modulation used in VDLM2 and VDLM3 transmissions at a nominal rate of 10,500 symbols per second.*** The VDR should implement the D8PSK modulation as defined in the ICAO SARPs for VHF Digital Link (VDL), as well as in Section 3.2.1 and Appendix F of RTCA DO-224A. ***The training sequence is part of the referenced definitions.***

COMMENTARY

At a rate of 10,500 symbols per second, D8PSK modulation provides a nominal RF channel bit rate of 31,500 bps.

4.2.8 Permissible Transmitter Variations

Because VDR implementations may differ widely, transmitter requirements are specified against an ideal model. This section lists the permitted variations from ideal.

4.2.8.1 Frequency Accuracy

The ***VDR*** transmitter carrier frequency accuracy should be within ±5 ppm.

COMMENTARY

This specification assumes that, for data operations in any mode, the ground station transmitter frequency stability is ±2 ppm.

4.2.8.2 Adjacent Channel Emissions (D8PSK)

COMMENTARY

Adjacent Channel emissions are a part of spurious emissions, covered in Section 4.2.8.6.

4.2.8.3 Transmitter Distortion (D8PSK)

Referring to the Differential Eight Phase Shift Key (D8PSK) transmitter implementation, the Error Vector Magnitude (EVM) of the transmitted D8PSK symbols, when averaged over the first 100 symbols of a burst sequence, should be less than 6%.

4 INTERFACES AND PROTOCOLS *WITH* THE GROUND SYSTEM (cont'd)

COMMENTARY

Error Vector Magnitude (EVM) is defined as the root mean square (rms) error in the in phase-quadrature phase (I-Q) vector magnitude measured at the ideal sampling points, expressed as a percentage. See RTCA DO-271A or DO-281, Section 1.7.9, for details. EVM also accounts for phase acceleration and amplitude/phase imbalance.

4.2.8.4 Transmitter Data Clock Stability ***(D8PSK)***

The VDR transmitter data modulation rate should be within ±50 ppm (parts per million) of its nominal rate.

4.2.8.5 Transmitter Frequency/Phase Performance (D8PSK)

[The total frequency change during the transmission of the 16 symbol unique sequence should be less than 10 Hz. After transmission of the unique sequence, the phase acceleration should be less than 150 Hz/sec.***]***

COMMENTARY

The EVM measurement (Section 4.2.8.3) takes account of phase acceleration effects.

4.2.8.6 Transmitter Spurious ***and Harmonic Emissions***

****[ed. note: This subsection remains in rework status, pending rationalization with revised SARPs, MASPS and MOPS. Completion is expected before the end of year 2002.]****

COMMENTARY

Spurious emissions are power emissions that are outside the necessary bandwidth. The level of such emissions may be reduced without affecting the corresponding transmission of information. In this document, spurious emissions include parasitic emissions, inter-modulation products and frequency conversion products; harmonic emissions are separately specified.

Any spurious emissions within the frequency band of 117 ***MHz*** to 137 MHz should comply with the specifications ***set forth in Table A6-2, "Adjacent Channel Emission Power Limits".***

4.2.8.6.1 Transmitter Spurious Emissions (DSB-AM and DSB-AM/MSK)

When operating with DSB-AM or DSB-AM/MSK modulation, the VDR should meet the spurious emission specifications of ARINC 716, Section 3.7.4.

4.2.8.6.2 Transmitter Spurious Emissions (D8PSK)

When operating with D8PSK modulation, the VDR transmitter's spurious emissions should meet the specifications of Table A6-2, "Transmitter -- Adjacent Channel Interference Power Limits", and Table A6-3, "General Spurious Emission Limits".

4 INTERFACES AND PROTOCOLS *WITH* THE GROUND SYSTEM (cont'd)

COMMENTARY

The specifications for spurious ***emissions are*** stated in terms of ***either*** absolute ***or relative*** power level rather than amount of attenuation by virtue of several historical agreements reached as a result of interference on harmonics of aeronautical mobile frequencies. For this reason equipment manufacturers should regard the ***value***s specified in this paragraph as "barely acceptable minima", and aim to do better in their LRUs.

Special measures to ensure protection of equipment operating in the GNSS band (1559 MHz to 1610 MHz) and the AMS(R)S band (1530 MHz to 1559 MHz) may be necessary in certain installations. See RTCA DO-271A or DO-281, Section 3.2.2, for further information.

Acceptable conditions and levels for the case of possible D8PSK interference to another VHF radio operating simultaneously with DSB-AM modulation have not yet been established. Currently, it is recommended that the isolation between the antennas of such radios be, at a minimum, consistent with ARINC 716, Section 3.6.7.4.

The level of spurious emissions at discrete frequencies, excluding harmonics, should not exceed -54 dBm in the following frequency bands:

47 MHz to 68 MHz,
88 MHz to 108 MHz,
162 MHz to 244 MHz,
328 MHz to 336 MHz, and
470 MHz to 862 MHz.

Harmonic emission products should be at least 60 dB below the rated RF output power; i.e., -60 dBc. Harmonic emission products in the Global Navigation Satellite System (GNSS) band extending from 1559 to 1610 MHz should be no greater than -60 dBm, where the level of the N^{th} harmonic emission product is measured in a bandwidth that is N times 25 kHz.

When the transmitter is "idle" (i.e., transceiver is in receive mode) and its antenna port is terminated in a resistive load equal to the nominal output impedance, the power of any spurious emission at the output of the transmitter should not exceed -57 dBm on any frequency in the following ranges:

9 kHz to 150 kHz, within a bandwidth of 1 kHz,
150 kHz to 30 MHz, within a bandwidth of 10 kHz, and
30 MHz to 1 GHz, within a bandwidth of 100 kHz.

COMMENTARY

To provide adequate protection for a GNSS receiver when a VDR transceiver is operated on the same aircraft, the manufacturers should ensure that the transmitter harmonic filter

4 INTERFACES AND PROTOCOLS *WITH* THE GROUND SYSTEM (cont'd)

remains effective at frequencies in the band 1559 - 1610 MHz. If other receiving systems are installed, VHF transmitter harmonics may interfere with those systems. Refer to RTCA DO-271A or DO-281, Section 3.2.2, for further information.

4.2.8.7 In-Band Spectrum Characteristics (D8PSK)

The in-band spectrum of the transmitted D8PSK signal should have a Raised Cosine shape with spectrum roll-off constant equal to 0.6 (see RTCA/DO-224***A***, Section 3.2.1.2.5). The allowable deviations from this ideal spectrum should be as specified in Table A6-1.

4.3 Receiver and Demodulator Control

4.3.1 Sensitivity and Dynamic Range

COMMENTARY

The following specifications are derived from ICAO VDL SARPs and VDL MOPS. VDL MASPS and MOPS have equivalent specifications for which practical equipment test procedures can be implemented. See RTCA DO-224A, with Changes 1 and 2; DO-271A and DO-281 for details.

4.3.1.1 DSB-AM and DSB-AM/MSK Modulation

A receiver operating with DSB-AM or DSB-AM/MSK modulation should meet all receiver specifications contained in ARINC Characteristic 716. Additionally, for a VDR operating in ***DSB-AM/***MSK mode***s***, the ***corrected*** Bit Error Rate output of the MSK demodulator ***and decoder*** should be equal to or less than 10^{-4} for a signal with a***n input*** power level of -98 dBm to -7 dBm.

4.3.1.2 D8PSK Modulation

For a VDR operating ***with*** D8PSK ***modulation***, the uncorrected Bit Error Rate output of the D8PSK demodulator should be equal to or less than 10^{-3} for a signal with a power level into a 50 ohm resistive load of -98 dBm to -7dBm. ***The receiver should achieve that bit error rate when a desired signal, at a level of -87 dBm at the receiver input port, is subject to a symbol rate offset of ±50 ppm, or when a desired signal exhibits peak phase accelerations up to 1000 Hz/s while the maximum frequency deviation falls within ±685 Hz of the desired channel frequency.***

COMMENTARY

Phase acceleration of the desired signal, as presented to the D8PSK demodulator, can be the result of Doppler offsets due to aircraft motion with respect to the ground station or other aircraft, and of residual frequency modulation of the desired signal due to characteristics of the other transmitter equipment (see, for example, Sections 4.2.8.3 and 4.2.8.4). The latter effect is expected to be the dominant source of phase acceleration.

4.3.2 Burnout Protection

The unit should not suffer permanent damage when subjected to a signal of +20 dBm or less.

4.3.3 Selectivity

For D8PSK, the receiver IF selectivity mask should be the same as used for ARINC 716 voice or data mode operation. The data demodulator selectivity mask should be designed to minimize the BER.

4.3.4 Interference Mitigation

The receiver/demodulator should be capable of successfully demodulating received signals in the noisy RF environment in which an aircraft normally operates. This section provides design guidance to manufacturers to enable them to meet the desires of their customers.

COMMENTARY

It should be noted that there is a potential for interference ***among*** multiple radios assigned to neighboring channels. ***Installations of VHF communications antennas should follow the guidance of ARINC 716, Section 3.6.7.4.***

4.3.4.1 Desensitization ***(DSB-AM and D8PSK)***

COMMENTARY

Circuitry should be included for the prevention, insofar as practicable, of receiver desensitization due to pulse-type interference. As the magnitude and character of the pulse interference levels expected in a typical installation in the future is not known, system performance specifications would be meaningless, and therefore this section is included as commentary. However, RF pulses of the following characteristics are typical of what can be expected.

Width of Pulse	10±2 microseconds
Repetition Rate	1000±100 pps
Waveform	Rise and Decay time each less than 1 microsecond

4.3.4.2 Adjacent Channel Signal Rejection ***(D8PSK)***

The receiving function should provide the specified BER ***of Section 4.3.1.2*** with a minimum desired signal ***level*** of -87 dBm applied at the input to the receiver and with a maximum undesired signal level on ***an adjacent channel as listed below:***

Adjacent Channel (Upper or Lower)	***Undesired Signal Level, Referenced to Desired Signal Level***
1st, 2nd and 3rd	***+40 dB***
4th and greater	***+60 dB***

COMMENTARY

The adjacent-channel undesired signals may be DSB-AM, ***DSB-AM/MSK*** or D8PSK signals. Note, however that when the undesired signal on the first adjacent channel is a D8PSK signal with emission characteristics per Section 4.2.8.2, the specified adjacent channel rejection cannot

be met given the desired signal-to-co-channel interference performance requirement specified in Section 4.3.4.4. Therefore, the EUROCAE ***ED-92, RTCA DO-271A and RTCA DO-281*** test procedures recommend using ***an "undesired test signal" defined as a continuous wave (CW) signal frequency modulated by a 400 kHz tone with a peak frequency deviation of 5.25 kHz. With such a signal,*** the adjacent channel emissions ***are significantly*** lower than those specified in Section 4.2.8.2.

4.3.4.3 Out-of-Band Interference Rejection Performance

When the VDR is operating with D8PSK modulation, the BER requirement (Section 4.3.1) should be achieved when one of the specified unwanted signals listed below is applied in addition to the desired signal at a reference signal level of -87 dBm.

Unwanted Signal ID	*Frequency Ranges (MHz)*	*Modulation*	*Level (dBm)*
A	***108.000 - 117.950 137.025 - 156.000***	***None***	***-33***
B	***0.05 - 87.5 156 - 1215***	***None***	***-7***
C	***87.5 - 107.9***	***None***	***-5***

COMMENTARY

In areas where adjacent higher-band signal interference exceeds this specification, a higher immunity requirement may be needed.

4.3.4.4 Co-Channel Interference Performance

The receiving function should provide the specified error rate with a desired signal of -87 dBm applied at the input to the receiver and with an undesired co-channel interference signal with level 20 dB lower than the desired signal.

4.3.4.5 Performance in the Presence of Strong Signals Within the VHF Aeronautical Band

The BER requirement (Section 4.3.1) should be achieved when a CW interfering signal of -33 dBm and the desired signal at -87 dBm are present at the receiver input. The frequency range of the interfering signal should be 118.000 to 136.975 MHz, including the in-band frequencies of the second upper and second lower adjacent channels to which the receiver is tuned but excluding the frequency range between these two adjacent channels.

4.3.5 Signal Quality Analysis

The link management ***functions of the following modes of operation require knowledge of the signal quality received by the aircraft from ground stations.***

a) ACARS, Modes 0 and A
b) VDL Mode 2
c) VDL Mode 3, in configuration 3T only.

COMMENTARY

SQP may be used in VDLM3 configurations other than 3T.
[TBD text for ACARS and VDLM2 is on agenda of VDL SC.]

Accordingly, ground station transmissions should be evaluated for signal quality and the signal quality should be passed to the link management function along with the address of the ground station.

COMMENTARY

The VDR may perform analysis of both the receiver and the channel, measuring such properties as phase distortion, coherence, ***signal level***, signal-to-noise ratio, and/or confidence of demodulation.

COMMENTARY

Manufacturers are advised against using the bit error rate as a ***signal-quality*** metric, as the transition band is too small.

4.3.6 Channel Sense Algorithm

4.3.6.1 Channel Sense Algorithm (DSB-AM)

The VDR should satisfy the channel sense ***algorithm*** performance ***requirements*** as defined in ARINC Characteristic 618.

4.3.6.2 Channel Sense Algorithm (D8PSK)

The VDR should satisfy the channel sense ***algorithm*** performance ***requirements*** as defined in the International Civil Aviation Organization (ICAO) Standards and Recommended Practices (SARPs) for VHF Digital Link (VDL).

4.4 Transmitter-Receiver Interaction

4.4.1 Transmitter-Receiver Interaction (DSB-AM/MSK)

The VDR should satisfy the transmitter-receiver interaction performance as defined in ARINC Characteristic 716.

4.4.2 Transmitter-Receiver Interaction (D8PSK)

The VDR should satisfy the transmitter-receiver interaction performance as defined in the ICAO SARPs for VDL.

4.5 Air/Ground Protocols

Beyond the Physical Layer requirements addressed in the preceding subsections, additional air/ground protocols are necessary to provide for identification of sender and intended recipient(s), for integrity of the information transferred and for network management purposes.

4.5.1 Analog Voice Communications (DSB-AM, 25 kHz and 8.33 kHz)

Air/ground protocols for analog voice operation are implemented through human operating procedures, spelled out in various publications including AIM and document ICAO Document 4444. These procedures are based on the use of standardized phraseology, pronunciation and formatting of message content.

COMMENTARY

Initial contact ("network entry") and subsequent communications include the following :

- ***a. Manual frequency selection to enable communication with the assigned or desired station;***
- ***b. Manual use of "listen-before-PTT" protocol to minimize "step-on" situations;***
- ***c. Verbal announcement of the identity of the intended receiving station, if the message is not intended as a "to all points" transmission;***
- ***d. Verbal announcement of the identity of the transmitting station (can also be coded; e.g., ATIS, FSS);***
- ***e. Verbal request for repeat of transmission, and repeated message, if reception is garbled; and***
- ***f. Verbal announcement of "PAN-PAN" and "MAYDAY" in urgent and emergency situations.***

4.5.2 Digital Communications

COMMENTARY

The introduction and evolution of digital communications technologies have afforded increasingly significant gains in the efficiency and integrity of air/ground communications. Common to all digital modes is the ability to automate certain aspects of air/ground communications that are performed manually in analog voice operations. Also common is at least a minimal set of machine-implemented air/ground protocols that are now recognized as the Link Layer and higher Layers of the OSI model, within which sublayers can exist to support specific functions.

4.5.2.1 ACARS Mode 0 (DSB-AM/MSK)

As the VDR-[C]MU interface passes MSK baseband signals, the MSK modem and the Link Layer features provided by ACARS Mode 0 reside in the [C]MU and are governed by ARINC Specification 618. All air/ground functionality required within the VDR is covered by Sections 4.1 through 4.4 above.

4.5.2.2 ACARS Mode A (DSB-AM/MSK)

For ACARS Mode A operation, the air/ground functionality defined in ARINC Specification 618 is split between the VDR and the [C]MU as defined in Attachment 11, which also describes the

ACARSIP protocol that interfaces those functions. The VDR should implement all functions allocated to it by Attachment 11.

4.5.2.3 VDL Mode 2 (D8PSK)

For VDLM2 operation, the Link Layer and LME functionality defined in the VDL SARPs and RTCA DO-224A is split between the VDR and the [C]MU as defined in Attachment 10, which also describes the ASIP protocol that interfaces those functions. The VDR should implement all functions allocated to it by Attachment 10.

4.5.2.4 VDL Mode 3 (D8PSK)

For VDLM3 Data operation, the Link Layer and LME functionality defined in the VDL SARPs and RTCA DO-224A is split between the VDR and the CMU as defined in Attachment 12, which also describes the V3SIP protocol that interfaces those functions. All such functions necessary to support Basic and Enhanced Voice Services are located in the VDR. The VDR should implement all functions allocated to it by Attachment 12.

4.5.3 VDR Status Information

The VDR should set the correct data, current at the time of transmission, in the fields of the following ARINC 429 words broadcast by the VDR:

429 Label	*Table Ref.*	*Section Ref.*	*Mode*
050	*A8-22*	*8.2.2.3.1*	*VDLM3*
051	*A8-23*	*8.2.2.3.2*	*VDLM3*
055	*A8-24*	*8.2.2.3.3*	*All modes*
172	*A8-7*	*5.5.1*	*All modes*
270	*A8-21*	*5.5*	*All modes*
377	*A8-9*	*5.5.3*	*All modes*

5 INTERFACE AND PROTOCOLS WITH THE CMU

5.1 ARINC Specification 429 Interface Definition

5.1.1 The Physical Layer

The VDR communicates with a CMU across a high-speed physical link as defined in ARINC Specification 429, "Mark 33 Digital Information Transfer System (DITS), Part 3, File Data Transfer Techniques".

5.1.2 Bit Oriented Protocols

Part 3 of ARINC Specification 429 defines Version 1 and Version 3 of the Williamsburg protocol for file data transfer. Both ARINC Specification 429 Bit Oriented Protocol (BOP) and conventional broadcast words are used to transfer information between the VDR and the CMU. Version 3 is used to support ACARS Mode A, VDL Mode 2 and VDL Mode 3. Version 1 may be used to support ACARS Mode A operation, but Version 3 is preferred if available. The specific version used is negotiated via the ALOHA process described in Part 3 of ARINC Specification 429.

The specific version used is negotiated via the ALOHA process described in ARINC Specification 429. Refer to Section 5.1.3.

Installations that require support of both Williamsburg Versions 1 and 3 in the VDR may need to dynamically switch between Williamsburg versions. This ***capability*** is supported ***by*** the ALOHA mechanism defined in ARINC Specification 429. For example, if the current mode of operation is Mode 2 using Williamsburg Version 3 and the next mode of operation is to be Mode A using Williamsburg Version 1, then the CMU will send an ALO word containing the Version 1 identifier. Upon receipt of the ALO word by the VDR and following the procedures outlined in Section 3.3.2, the VDR's CMU_STATUS state variable will change to PRIMARY and then BOP as the Version 1 is successfully negotiated. The CMU would then send a MODE_SET.request primitive as before to set the new protocol to the Mode A protocol.

5.1.2.1 ARINC Specification 429 BOP Version 1 (Williamsburg Version 1)

For a detailed explanation of the ARINC Specification 429 BOP, as well as definitions of the ARINC Specification 429 BOP word formats, refer to ARINC Specification 429, "Mark 33 Digital Information Transfer System (DITS), Part 3, File Data Transfer Techniques," Section 2.5.

The VDR uses unique timer values for the high speed Version 1 BOP in order to provide the specified performance. The VDR ARINC Specification 429 timer values are shown in Attachment 8, Table A8-16. The CMU uses the standard Version 1 timers, except for the word gap. The VDR and CMU word gap should be 4 to 8 bits. The CMU and VDR should complete the CRC check within 10 milliseconds of receiving the EOT word.

COMMENTARY

> The modified Version 1 timers in the VDR were selected in order to maintain interoperability with standard Version 1.

The following options should be used in a Williamsburg Version 1 implementation of the CMU/VDR interface (options described in ARINC Specification 429, Part 3, Table 10-3a):

5 INTERFACE AND PROTOCOLS *WITH* THE CMU (cont'd)

Option	Description	Default
O_1	Half or Full Duplex	Half
O_2	High or Low Speed Bus	High
O_3	Automatic CTS When Ready	Yes
O_4	Accept Automatic CTS	Yes
O_5	SYS Priority to Resolve Conflict	CMU
O_6	Reserved	
O_7	Reserved	
O_8	Use of SOLO Word	Yes
O_9	Reserved	
O_{10}	Destination Code Required	Yes
O_{11}	Bit-Protocol Verification (ALO/ALR Protocol Determination)	Yes
O_{12}	Use Subsystem SAL from ALO word	No

5.1.2.2 ARINC Specification 429 BOP Version 3 (Williamsburg Version 3)

For a detailed explanation of the ARINC Specification 429 BOP, as well as definitions of the ARINC Specification 429 BOP word formats, refer to ARINC Specification 429, "Mark 33 Digital Information Transfer System (DITS), Part 3, File Data Transfer Techniques," Section 3.

The following options should be used in the Version 3 BOP of the CMU/VDR interface (options described in ARINC Specification 429, Part 3, Table 10-3b):

5 INTERFACE AND PROTOCOLS *WITH* THE CMU (cont'd)

Option	Description	Default
O_1	Half or Full Duplex	Full
O_2	High or Low Speed Bus	High
O_3	Automatic CTS When Ready	N/A
O_4	Accept Automatic CTS	N/A
O_5	SYS Priority to Resolve Conflict	N/A
O_6	Spare	--
O_7	Spare	--
O_8	Use of SOLO Word	Yes
O_9	Reserved	--
O_{10}	Destination Code RTS/CTS/NCTS/BUSY used	N/A
O_{11}	Bit-Protocol Verification	Yes
O_{12}	Use Subsystem SAL from ALO word	No
O_{13}	Use of information or Command Frames	Command Frame
O_{14}	Use of Pause Function	No
O_{15}	Generate 32 bit CRC for information frame	N/A

The CMU-VDR interface uses Command frames and Solo words. Information frames are not used by the CMU-VDR interface.

5.1.2.3 ARINC Specification 429 Flow Control

The VDR and CMU should respond according to ARINC 429 requests for flow control of the transfer of BOP files. The CMU and VDR may provide a mechanism by which it can request flow control of the transfer of BOP.

No method of controlling the flow of SOLO words is provided.

The CMU and VDR use two types of files, COMMAND and DATA. A file of type DATA will contain user data intended for peer-to-peer network communications. A file of type COMMAND will contain all other data typically used for CMU-to-VDR management and Interface Protocol configuration functions. The functional context of the types of files transferred requires that a selective form of flow control be implemented whereby the flow of files of one type is allowed to occur, but the flow of files of another type is not.

Flow control is implemented in different ways for the two versions of the Williamsburg protocol.

5.1.2.3.1 Version 1 Flow Control Mechanism

ARINC 429 flow control for Version 1 is implemented with the protocol words RTS, CTS, NCTS, and BUSY See Section 2.5 of ARINC Specification 429, Part 3. The Destination Code field of the Version 1 Williamsburg protocol word identifies the file type. Files of type COMMAND are identified by a Destination Code of 00_h. Files of type DATA are identified by a Destination Code of 01_h.

5.1.2.3.2 Version 3 Flow Control Mechanism

Flow control by the VDR when using Version 3 is implemented by the use of XON.request and XOFF.request primitives (see Section 5.3.3.2) defined herein. The XON.request and XOFF.request primitives are SOLO words and thus are not subject to flow control procedures.

The Start of File (SOF) word in the Command Frame Data Unit contains a field called the Command Type (CT) field. Files of type COMMAND are identified by a Command Type (CT) Field content corresponding to "Command".

Files of type DATA are identified by a CT Field content corresponding to "Data" as defined in Section 3.4.6.3.4 of ARINC Specification 429, Part 3.

The bit definitions of the CT field of the Start of File (SOF) word in the Command Frame Data Unit are as follows:

Bit 24	Bit 23	Meaning
0	0	Command
0	1	Data
1	0	MAC Control
1	1	Reserved

Version 3 of ARINC 429 contains a MAC Control primitive for flow control, but it should not be used because it affects files of all types.

5.1.3 Multiple CMU/VDR Protocol Support

Both ARINC Specification 429 Bit Oriented Protocol (BOP) and conventional broadcast data words are used to transfer information between the VDR and the CMU. Two versions of the ARINC 429 Williamsburg File Data Transfer protocol can be used. Both Williamsburg Version 1 and Version 3 can be used for file transfer when the aircraft is configured to operate in VDR Mode A. Version 3 should be used in all cases when the aircraft is operating VDL Mode 2 **or VDL Mode 3**.

COMMENTARY

> Version 3 of the Williamsburg protocol is necessary to support the throughput of ***VDL*** Mode 2 ***and VDL Mode 3***. ACARS throughput, being much slower, can be accommodated by Version 1 of the Williamsburg protocol.

The CMU is designed to communicate as part of an air-ground network consisting of many layers of protocols (see ARINC Characteristic 758, ARINC Specifications 631 and 637***, and "Specification 63Z"***). The protocols the CMU uses to communicate with its peers on the ground are referred to as Data Link Protocols; ARINC 631 and ARINC 618 are examples. The CMU and VDR communicate with each other using a local protocol designed to work within the aircraft and support the functionality of the air-ground Data Link Protocol. The protocol used between the CMU and VDR is referred to as a CMU/VDR Interface Protocol, or simply Interface Protocol and is defined herein. The CMU/VDR

interface is defined so that the CMU can select, control and switch air-ground protocols in real time as conditions require.

COMMENTARY

For example, the CMU may be part of the ATN network which requires that communications with the ground use VDL Mode 2 air-ground Protocol. Then the aircraft flies out of range of the ATN network and the CMU attempts to switch to the ACARS air-ground protocol in order to determine if that service is available. The CMU, via the CMU/VDR interface would command the VDR to switch to Mode A.

Various CMU/VDR configurations may exist in the industry.

a. ACARS VDR operating Mode A only.
b. VDL operating Mode 2 only.
c. Both VDR Mode A and VDL Mode 2 (The mode is selected dynamically by CMU link management software.)
d. VDR Mode A, VDL Mode 2, and VDL Mode 3.

For ***the*** third a***nd fourth*** configurations, when the air/ground operation is transferred from VDL Mode 2 ***or VDL Mode 3*** to VDR Mode A (or vice versa), the version of ARINC 429 Williamsburg protocol may need to be renegotiated as well.

COMMENTARY

These provisions are included to address ***certain*** transition case***s***; e.g., where the aircraft leaves VDL Mode 2 coverage and falls back on ACARS (VDR Mode A) to maintain air/ground data communications. Some VDR manufacturers may implement Version 3 of the ARINC 429 BOP only. And, some CMUs (presumably ATSUs) will be designed to require ARINC 429 Williamsburg Version 1 connectivity with the VDR when the air/ground link is ACARS (VDR Mode A). The combination of these two units must be avoided if interoperability is to be preserved.

The CMU may have access to multiple VDRs and may configure them differently or the same. The CMU may communicate with more than one radio at a time.

Primitives defined as part of a ***particular VDR/CMU*** Interface Protocol are uniquely associated with that protocol. Every primitive contains a data field that indicates to which ***VDR/CMU*** Interface Protocol it belongs. For primitives sent as BOP files, this identifier is called an Extended General Format Identifier (EGFI) and a file that contains an EGFI will be referred to as an Extended BOP File. For primitives sent as SOLO words this identifier is called an Extended Identifier (EID) and a SOLO word that contains an EID will be referred to as an Extended SOLO Word.

5.1.3.1 Extended BOP File Format

An EGFI code identifies the Interface Protocol that created the associated BOP file. Table A8-13 contains a listing of ***CMU/VDR*** Interface Protocols and their corresponding EGFI codes.

5 INTERFACE AND PROTOCOLS *WITH* THE CMU (cont'd)

The general format for all Extended BOP files is as follows:

Octet	Definition
1	EGFI
2	Primitive Identifier (PID)
3	Data Field Length MSB
4	Data Field Length LSB
5	Data Field Byte #1
6	Data Field Byte #2
.	.
.	.
.	.
N+4	Data Field Byte #N

Whether a BOP file contains an EGFI as the first octet of the file is indicated by the content of the General Format Identifier (GFI) field in the first word of the file. The location of the GFI field is dependent upon whether Williamsburg Version 1 or Version 3 is being used for the file transfer.

5.1.3.1.1 Williamsburg Version 1 GFI

For Williamsburg Version 1 implementations, the GFI field is included as part of the Start Of Transmission (SOT) word which begins all version 1 BOP file transfers. It is predefined in ARINC Specification 429, Part 3, Table 11-6A. A code of "F_h" in the GFI field location indicates that an EGFI occupies the first data octet of the first data word in the file and that the file is an Extended BOP File.

5.1.3.1.2 Williamsburg Version 3 GFI

For Williamsburg Version 3 implementations, the GFI field is included as part of the SOF word which begins all Command Frame transfers. It is predefined in ARINC Specification 429, Part 3, Table 11-6A. A code of "F_h" in the GFI field location indicates that an EGFI occupies the first data octet of the first data word in the file and that the file is an Extended BOP File.

5.1.3.2 SOLO Word EID Code

ARINC Specification 429 does not provide an intrinsic mechanism by which SOLO words can be uniquely associated with a particular Interface Protocol. An extension to ARINC Specification 429 is defined herein to provide this capability.

The ID field (see ARINC Specification 429 Table 11-5) identifies SOLO words. A code of "F_h" in the ID field location indicates that an EID occupies bits 21-24 of the SOLO word and that the SOLO word is an Extended SOLO Word. An EID code identifies the Interface Protocol of which the SOLO word is a part. Table A8-13 contains a listing of Interface Protocols and their corresponding EID codes.

The general format for all Extended SOLO words is as follows:

Bit	Definition	Comment
32	Parity	odd parity
31-29	"101_b"	(indicates SOLO)
28-25	"F_h"	(indicates Extended SOLO Word)
24-21	EID	(indicates which Interface Protocol)
20-09	***Undefined***	***CMU/VDR Interface Protocol specific data field***
08-01	SAL	

COMMENTARY

Bits 9 through 20 are left undefined. The definition of these ***bits is contained in the Attachment that defines a particular CMU/VDR Interface Protocol.***

5.1.4 Full and Partial Data Word Formats

The CMU and VDR encode the information in octets as defined in ARINC Specification 429.

5.2 *Data Operation with VDR/CMU Interface*

The status of the CMU/VDR interface is represented by the state variable CMU_STATUS. The interface is considered to have entered the CMD state once the conditions outlined in Section 3.3.3 Table 3-1 have been met. When the CMU_STATUS is CMD, the VDR is expected to respond to command and control messages, and other ARINC Specification 429 BOP initialization procedures. These procedures include the air-ground protocol selection process.

The CMD state contains three substates: PROTOCOL_NULL, PROTOCOL_RESET, and PROTOCOL_SET.

5.2.1 PROTOCOL–NULL

The PROTOCOL_NULL substate is ***contained within the CMD state and is the initial sub-state for CMD. It is entered when CMD is entered,*** that is when the ***CMU_STATUS transitions from BOP to CMD through the exchange of MODE_SET.request and MODE_SET.confirm messages as described in Section 3.3.6.*** While in this substate, the VDR sets to "1" the Protocol Status bit ***14*** and sets the Download Request bit ***11*** to "0" in its Label 270 status word.

5.2.2 PROTOCOL–RESET

In the PROTOCOL_RESET substate, the CMU has selected a CMU/VDR interface protocol but no protocol-specific operational parameters have been set. While in this substate the VDR sets the Download Request bit to "1" and the Protocol Status bit to "1" in its Label 270 status word.

5.2.3 PROTOCOL_SET

In the PROTOCOL_SET ***substate,*** the CMU has ***provided (or requested) the protocol-specific*** operational parameters needed to begin operation. While in this ***substate***, the VDR sets the Download Request bit to "0" and the Protocol Status bit to "1" in its Label 270 status word.

5.2.4 Protocol State Diagram

Figure 5-1 below contains the Protocol State Diagram and shows the protocol substates that the ***CMU/VDR interface*** may have once it has entered the ***CMD*** state. The inputs and outputs for the state transitions are the transmission and/or receipt of (1) certain Command and Control primitives***, and (2) one protocol-specific primitive (PARAM.request/PARAM.confirm) that is common to all of the CMU/VDR Interface Protocols***

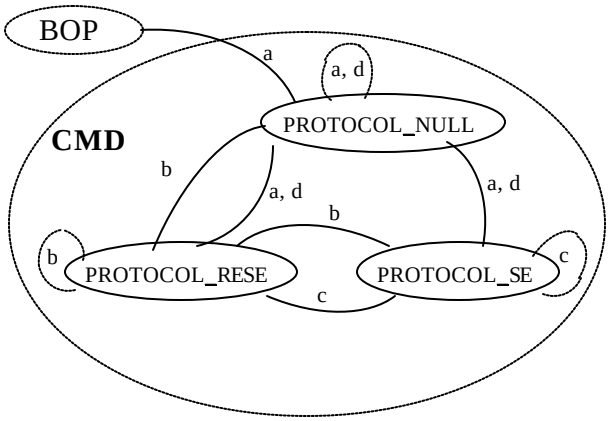


Figure 5-1 Protocol State Diagram

a. MODE_SET.request received, MODE_SET.confirm sent.

b. PR_SET.request received, PR_SET.confirm sent (non-error).

c. PARAM.request received, PARAM.confirm sent (non-error).

d. PR_SET.request received, PR_SET.confirm sent (error or non-supported protocol).

It is possible for a CMU to unambiguously determine which of the ***CMU/VDR interface protocol substates of the CMD state*** the VDR is in by examining the contents of the Download Request bit and the Protocol Status bit in the VDR's broadcast Label 270 word.

The following table shows the CMU/VDR interface protocol substates of the CMD state as a function of these two bits:

Protocol State	Download Request Bit	Protocol Status Bit

PROTOCOL_NULL	0	0
PROTOCOL_RESET	1	1
PROTOCOL_SET	0	1

5.3 VDR Control

As the CMU and VDR may support multiple Interface Protocols, a protocol-independent control mechanism is provided to manage the air-ground protocol selection, BITE data reporting, and other air-ground protocol-independent functions. These functions are managed using VDR Control primitives comprised of conventional (non-extended) BOP files and SOLO words.

5.3.1 VDR Control Message Format

The primitives used for VDR control functions comprise VDR Control (BOP) files and VDR Control SOLO words.

For all VDR Control files, the ARINC 429 GFI field should be set to "2_h". All VDR Control files are of type COMMAND. When ARINC 429 BOP Version 1 is used, then the Destination Code in the 429 RTS word for VDR Control files should be set to "00_h" (to indicate a Command Type file). When ARINC 429 BOP Version 3 is used, then the Command Type field in the 429 SOF word for VDR Control files should be set to "Command". The general format for all VDR Control files is as follows:

Octet	Definition
1	Primitive Identifier
2	Data Field Length MSB
3	Data Field Length LSB
4	Data Field Byte #1
5	Data Field Byte #2
.	.
.	.
.	.
N+3	Data Field Byte #N

For all VDR Control SOLO words, the SOLO word ID field (bits 28-25), should be set to "2_h".The general format for all VDR Control SOLO words is as follows:

Bit	Definition
32	Parity
31-29	"101_b" (indicates SOLO)
28-25	"2_h"
24-17	Primitive Identifier (PID)
16-09	8-Bit Data Field
08-01	SAL

The VDR, regardless of any Interface Protocol it may consider to be active should respond to VDR Control messages.

5.3.2 Protocol Negotiation

The VDR Control messages are used to negotiate the air-ground Interface Protocol. The CMU is the controlling entity during the air-ground protocol selection process. The VDR should use the protocol that the CMU requests. To manage the protocol selection process the CMU is provided two primitives, PR_SET.request and PR_QUERY.request.

The VDR is provided two primitives for responding to the CMU primitives, PR_SET.confirm and PR_QUERY.confirm.

All protocol negotiation primitives are generated using VDR Control messages. A Protocol Identifier Code (PIC) is passed in the primitives to identify an Interface Protocol. Interface Protocols and their corresponding PICs are listed in Attachment 8, Table A8-13.

5.3.2.1 PR–SET.request Primitive

The CMU sends the PR_SET.request to the VDR to set the active protocol in the VDR.

Message format

The message consists of a VDR Control SOLO word, formatted as follows:

Bit	Definition	Content
32	Parity	
31-29	"101_b"	
28-25	ID field	2_h
24-17	PID	01_h
16-09	8-Bit Data	Requested PIC (Table A8-13)
08-01	SAL	

Response

The VDR responds with a PR_SET.confirm message within one second of receipt of the PR_SET.request message.

State

This message is processed while the ***CMU_STATUS state is CMD (states S7 or S8)***.

New State

The CMU_STATUS state remains CMD. This primitive initiates a substate change within the CMD state (see Section 5.3.2.2).

5.3.2.2 PR–SET.confirm Primitive

The VDR sends the PR_SET.confirm within one second of its receipt of a PR_SET.request from the CMU.

If the VDR supports the protocol requested in the PR_SET.request, then it enters the state ***PROTOCOL_SELECTED***. If the VDR does not support the requested protocol, then it enters the state PROTOCOL_NULL.

Message Format

The message consists of a VDR Control SOLO word, formatted as follows:

Bit	Definition	Content
32	Parity	
31-29	"101_b"	
28-25	ID field	2_h
24-17	PID	01_h
16-09	8-Bit Data	Confirmed PIC or ERROR protocol code (Table A8-13)
08-01	SAL	

Response

None.

State

This message is transmitted when ***CMU_STATUS state is CMD***.

New State

If the data field does not contain the ERROR code, then the resulting state is the PROTOCOL_RESET substate. If the data field contains the ERROR code, then the resulting state is the PROTOCOL_NULL substate.

5.3.2.3 PR–QUERY.request Primitive

The CMU issues the PR_QUERY.request message to request the VDR to send a list of supported protocols.

Message Format

The message consists of a VDR Control SOLO word, formatted as follows:

Bit	Definition	Content
32	Parity	
31-29	"101_b"	
28-25	ID field	2_h
24-17	PID	02_h
16-09	8-Bit Data	don't care
08-01	SAL	

Response

The VDR should respond with a PR_QUERY.confirm message within one second of receipt of the PR_QUERY.request message.

State

This message is processed when ***CMU_STATUS state is CMD***.

New State

The resulting state is unchanged.

5.3.2.4 PR–QUERY.confirm Primitive

The PR_QUERY.confirm primitive is sent by the VDR within one second of the receipt of a PR_QUERY.request and contains a list of the VDR's supported protocols.

Message Format

This message consists of a VDR Control file of type COMMAND. The file should contain the following:

Octet	Definition	Range
1	PR_QUERY.confirm	02_h
2	Data field length MSB	0-255
3	Data field length LSB	0-255
4	PIC #1	Table A8-13
5	PIC #2	Table A8-13
.	.	
.	.	
.	.	
N+3	PIC #N	Table A8-13

Response

None.

State

This message is transmitted ***when CMU_STATUS state is CMD***.

New State

The resulting state is unchanged.

5.3.2.5 MODE–SET.request Primitive

The CMU issues the MODE_SET.request message to set the ***CMU/***VDR ***Interface to the CMD state***.

Message Format

The message consists of a VDR Control SOLO word, formatted as follows:

Bit	Definition	Content
32	parity	
31-29	101_b	
28-25	ID	02_h
24-17	PID	05_h
16-09	8-Bit Data	don't care
08-01	SAL	

Response

The VDR responds with a MODE_SET.confirm message and enters the ***PROTOCOL_NULL sub***state of state ***CMD***.

State

This message is processed while ***the CMU_STATUS state is BOP or CMD. If the CMU_STATUS state has any other value then the VDR should ignore this message***.

New State

The resulting state is unchanged.

5.3.2.6 MODE–SET.confirm Primitive

The VDR sends the MODE_SET.confirm message within one second of receipt of a MODE_SET.request message.

Message Format

The message consists of a VDR Control SOLO word, formatted as follows:

Bit	Definition	Content
32	parity	
31-29	101_b	
28-25	ID	02_h
24-17	PID	05_h
16-09	8-Bit Data	don't care
08-01	SAL	

Response

None

State

This message is transmitted while the ***CMU_STATUS state is BOP or CMD***.

New State

The resulting state is the PROTOCOL_NULL substate of state ***CMD***.

COMMENTARY

When CMU_STATUS is BOP, the MODE_SET.request to MODE_SET.confirm handshake results in the ***CMU_STATUS*** transitioning to ***CMD and its initial substate PROTOCOL_NULL***. The MODE_SET.confirm message is shown to be valid when the ***CMU_STATUS*** ***is BOP or CMD***. The transition to ***CMD*** is implied to occur after the successful sending of the MODE_SET.confirm message.

5.3.3 Flow Control Primitives

As mentioned in Section 5.1.2.3.2, two primitives are provided with which flow control can be requested by the VDR or CMU.

5.3.3.1 XOFF.request Primitive

The VDR sends the XOFF.request message to request that the CMU send no further BOP files of the type specified in the Type Field.

Message Format

The message consists of a VDR Control SOLO word, formatted as follows:

Bit	Definition	Content
32	parity	
31-29	101b	
28-25	ID	02h
24-17	PID	06h
16-09	Type Field (8-bits)	00h = Command 01_h = Data
08-01	SAL	

Response

None.

State

This message is transmitted while ***CMU_STATUS state is BOP or CMD***.

New State

The resulting state is unchanged.

5.3.3.2 XON.request Primitive

The VDR sends the XON.request message to request that the CMU freely send BOP files of the type specified in the Type Field.

Message Format

The message consists of a VDR Control SOLO word, formatted as follows:

Bit	Definition	Content
32	parity	
31-29	101b	
28-25	ID	02h
24-17	PID	07h
16-09	Type Field (8-bits)	00h = Command 01_h = Data
08-01	SAL	

Response

None

State

This message is transmitted while ***the CMU_STATUS state is BOP or CMD***.

New State

The resulting state is unchanged.

5.3.4 BITE Data

Upon request the VDR conveys a limited amount of BITE data to the CMU. The purpose of sending BITE information to the CMU is to report the relative health of the VDR for installations which do not include a Central Fault Display System (CFDS). The CMU BITE information is meant to be a subset of the information made available to the CFDS. The VDR should only inform the CMU of its present health state. There is no requirement for the VDR/CMU interface to support fault recording and the variety of CFDS menu modes supported for the CFDS. It is not the intent of this function to be compliant with ARINC Report 604 or 624.

The following ***list*** defines the different types of BITE data parameters which the VDR may send to the CMU:

BITE Boolean
VSWR
SW Part Numbers

All BITE data parameters comprise multiple bytes arranged in a common format, are sent in one BOP file, and conform to the general format shown in Section 5.3.1 Command and Control Message Format.

5.3.4.1 VDR–BITE.request Primitive

The CMU issues the VDR_BITE.request message to request the VDR to send a list of current BITE data.

Message Format

The message consists of a VDR Control SOLO word, formatted as follows:

Bit	Definition	Content
32	Parity	
31-29	"101_b"	
28-25	ID field	2_h
24-17	PID	03_h
16-09	8-Bit Data	don’t care
08-01	SAL	

Response

The VDR responds with a VDR_BITE.confirm message within one second of receipt of the VDR_BITE.request message.

State

This message is processed while ***the CMU_STATUS state is BOP or CMD***.

New State

The resulting state is unchanged.

5.3.4.2 VDR–BITE.confirm Primitive

The VDR sends the VDR_BITE.confirm message which contains all of the available BITE information.

Message Format

This message consists of a VDR Control file whose type is COMMAND. The file should contain BITE Boolean, VSWR, and software part numbers formatted as follows:

Octet	Definition	Range
1	VDR_BITE.confirm	03_h
2	Data field length MSB	0-255
3	Data field length LSB	0-255
4	Bite Booleans MSB	$0\text{-}FF_h$
5	Bite Booleans LSB	$0\text{-}FF_h$
6	VSWR	$10_h\text{-}FF_h$
7	N, number of part numbers contained in the file.	
8	M, number of ISO-5 characters per part number.	
9	PN1, char 1	
10	PN1, char 2	
.	.	
.	.	
8+M	PN1, char M	
9+M	PN2, char 1	
10+M	PN2, char 2	
.	.	
.	.	
8+2M	PN2, char M	
.	.	
.	.	
8+NM	PNN, char M	

BITE Booleans

The BITE Booleans should be formatted as follows:

MSB bit discretes

Bit	Description	Content
8	VDR failure	1 = failed
7	Antenna failure	1 = failed
6	DFS bus #1 status	1 = inactive or not examined
5	DFS bus #2 status	1 = inactive or not examined
4	CMC 1 bus activity bit	1 = inactive
3	CMC 2 bus activity bit	1 = inactive
2	Bit 4 valid	1 = invalid
1	Bit 3 valid	1 = invalid

COMMENTARY

Certain hardware implementations may not have the capability to simultaneously examine DFS bus #1 and DFS bus #2. For the DFS buses, a value of "1" for bits 5 or 6 will indicate that the corresponding bus is either not active or is not being examined. Similarly, the hardware may lack the ability to simultaneously examine CMC1 bus and CMC2 bus. If the value reported for CMC1 bus activity in bit 4 is valid (bus is being examined), then bit 2 will indicate "valid". Similarly, the content of bit 1 validates the content of bit 3.

LSB bit discretes

LSB bit discrete is reserved for future use and should be set to 00_h until defined otherwise.

VSWR

The VSWR byte provides a means of encoding a VSWR of 1.0:1 to 15.0:1 with a 0.0625 step size. The valid range for this byte is from 10_h to FF_h.

Software Part Numbers

The software part numbers are encoded in octets 9 through 8 + N * M. Each octet contains a character of the part number as an ISO-5 character. The VDR's software part numbers should be encoded using ISO-5 characters. The VDR should transmit the software part number in an order that sends the most significant digit first, least significant digit last. For example, the "6" should be the first character transmitted in the following 10 character software part number: 6 5 3 9 8 3 1 0 0 1. Part numbers should be 24 characters or fewer. The number of part numbers should be limited to eight.

Response

None.

State

This message is transmitted while the CMU_STATUS ***state*** is BOP or CMD.

New State

The resulting state is unchanged.

5.3.5 Error Messages

If either the VDR or CMU experiences an error in VDR Control communications, the unit experiencing the error should notify its counterpart of the error by sending an ERROR.indication message.

Message Format

The message consists of a VDR Control SOLO word, formatted as follows:

Bit	Definition	Content
32	Parity	
31-29	"101_b"	
28-25	ID field	2_h
24-17	PID	00_h
16-09	Error Code	PID of offending primitive or "FF_h" for unspecified error.
08-01	SAL	

Response

None.

State

This message is valid while the CMU_STATUS ***state*** is BOP or CMD.

New State

The resulting state is unchanged.

5.4 (Reserved)

5.5 Periodic Data

The VDR and CMU transmit periodically certain ARINC Specification 429 broadcast words. Periodic data is communicated using ARINC Specification 429 broadcast words.

The VDR should periodically transmit the following ARINC Specification 429 words to the CMU ***at the specified minimum rate:***

Label	Description	Rate
172	VDR System Address Label	1/sec
270	VDR Real-time status	***4***/sec
377	VDR Equipment ID	1/sec

The VDR should expect to periodically receive the following list of ARINC Specification 429 words from the CMU.

Label	Description	Rate
172	CMU System Address Label	1/sec
270	CMU Real-time status	1/sec

5.5.1 VDR's System Address Label Word (***Label*** 172)

The purpose of the transmitted ARINC 429 Label 172 word is to inform the CMU of the VDR's SAL and supported air-ground protocols. The format of the Label 172 word is shown in Table A8-7. The SAL field (bits 16-9), defined in Table A8-10, is set as a function of the transceiver's SDI strapping. The air-ground protocol field (bits 17-24) are set as a function of the air-ground protocols supported by the VDR. See Table A8-7. If bits 17-24 are all zero, then this will be understood to mean that the only VDL mode supported by the VDR is mode A. The PAD field (bits 25-29) are reserved for future growth and should be set to 0.

5.5.2 VDR's Status Word (***Label*** 270)

The transmitted ARINC 429 Label 270 word is used to inform the CMU of real-time status data. The format of the Label 270 word is shown in Table A8-8. The SDI codes (bits 9, 10) should be set in accordance with the SDI strapping of the transceiver as defined in Table A8-12. The PAD bits are reserved for future growth and should be set to "0". The settings for the SSM Field (bits 30, 31) are defined in Table A8-11.

5.5.2.1 Primary CMU Field

As defined in Section 3.3.2.1.4 Primary CMU Notification, the Primary CMU Field (bits 15, 16) are used to indicate which CMU the VDR considers to be PRIMARY and should be set to the SDI code of the PRIMARY CMU. If neither CMU is declared to be PRIMARY, then both bits in the field should be set to "1".

5.5.2.2 Protocol Status Bit

The VDR sets the Protocol Status bit (bit 14) in its Label 270 word to a "1" whenever it is in the PROTOCOL_RESET substate of state ***CMD***. The VDR sets the bit to a "0" at all other times.

5.5.2.3 Download Request Bit

The VDR sets the Download ***R***equest bit (bit 11), in its Label 270 status word, to a "1" whenever it is in the PROTOCOL_RESET substate of state ***CMD***. The VDR sets the bit to a "0" at all other times.

5.5.2.4 VDR Status Bit

The VDR Status bit (bit 18), is used to convey information about the operational health of the VDR. Anytime the VDR considers itself to be in a fault state, this bit should be set to a "1". Otherwise, this bit should be set to a "0".

5.5.2.5 Transmission Time-out Warning Bit

The Transmission Time-out Warning bit (bit 13) should be set to a "1" if less than five seconds remain until the time-out function disables the transmitter or if the time-out function has disabled the transmitter. Otherwise, this bit should be set to a "0".

5.5.2.6 Voice/Data Status Bit

The Voice/Data status bit (bit 17) should be set to a "1" if the ***VD_STATUS state is VOICE (see Section 3.3.1), and should be set to "0" otherwise***.

5.5.2.7 ***CMD Status Bit***

The ***CMD Status*** bit (bit 19) ***should be set to a "1" if the CMU_STATUS state is CMD (see Section 3.3.2); and should be set to "0" otherwise.***

5.5.2.8 ***CMU/***VDR ***Interface*** State

The ***CMU/***VDR ***interface*** state field, bits 21-24, is used to indicate the current state of the ***ARINC 429 interface between the*** VDR ***and the CMU,*** as defined in Table ***A8-8***.

5.5.2.9 Active Air-Ground Protocol

The Active Air-***G***round Protocol field, bits 25-27, is used to indicate which air-ground protocol is active. These bits are set to 0 when the VDR is ***operating*** in ***ACARS Mode 0 or DSB-AM Voice modes***. See Table A8-8.

5.5.2.10 VDLM3 Data Service Status

When the VDR is operating in VDL Mode 3, the VDLM3 Data Service Status field (Label 270, bits 28 and 29) are used to indicate whether the VDLM3 Ground Station supports Data Services and whether the VDR has entered the VDLM3 Network. These bits are set to 0 when it is not known if the ground station supports VDLM3 data services, and when the VDR is not operating in Mode 3. See Section A12.4.6 and Table A8-8.

c-2

c-2

c-1

c-1

5.5.2.11 DLS Enable Bit

The setting of the DLS Enable Bit (bit 12), when the VDR is operating in VDLM3, is defined in Attachment 12; otherwise, it is set to "0".

5.5.3 Transmitted Equipment Identification Word

The ARINC 429 Label 377 word is used to transmit the VDR's equipment identification code to the CMU. The format of the Label 377 word is shown in Table A8-9. The SDI codes (bits 9, 10), should be set in accordance with the SDI strapping of the transceiver as defined in Table A8-12. The Equipment Class field (bits 11-22), is set to "016_h" which identifies the LRU as a "VHF Transceiver". The PAD Field (bits 23-29) should be set to "0". The SSM code should be set to "Normal" as defined in Attachment 8, Table A8-11.

5.5.4 Received System Address Label Word

The VDR should receive an ARINC 429 Label 172 data word from the CMU over the high speed ARINC Specification 429 interface. The ARINC 429 Label 172 data word contains the SAL of the CMU. The format of the received ARINC 429 Label 172 word is defined in ARINC Characteristic 758 "Communications Management Unit (CMU) Mark-2".

5.5.5 Received Status Word

The VDR should receive an ARINC 429 Label 270 word from the CMU over the high speed ARINC Specification 429 interface. The ARINC 429 Label 270 data word contains information on whether the CMU is "active" or in "standby" mode.

Bit 20 is defined to be the Active/Standby bit.

The VDR considers the CMU active and available for ARINC 750 protocol operations only if bit 20 is set to "1". The format of the received ARINC 429 Label 270 word is defined in ARINC Characteristic 758 "Communications Management Unit (CMU) Mark 2".

5.5.6 Transmitted VDLM3 Status Word

The ARINC 429 Label 051 VDLM3 Status word is transmitted by the VDR only when the VDR is tuned to a VDLM3 channel. This word is transmitted regardless of whether the channel to which the VDR is tuned is valid for the configuration of the frequency by the ground system.

COMMENTARY

Example of an invalid channel: The Label 031 word from the RTP commands the VDR to tune to slot "D" at a frequency of 118.500, but the ground system configuration for that frequency is a 2V1D, a three slot system. The VDR will send both the VDLM3 Status word (Label 051) and the VDLM3 Information Word (Label 055) to the RTP. However, the VDL Service Level Status field of the transmitted VDLM3 Status Word will indicate "Invalid Voice Channel".

5 INTERFACE AND PROTOCOLS *WITH* THE CMU (cont'd)

6 PROVISIONS FOR AUTOMATIC TEST EQUIPMENT (ATE)

6.1 General

To enable Automatic Test Equipment (ATE) to be used in the bench maintenance, internal circuit functions not available at the unit service connector and considered by the equipment manufacturer necessary for automatic test purposes may be brought to pins on an auxiliary connector of a type selected by the equipment manufacturer. This connector should be fitted with only that number of contacts needed to support the ATE functions. The connector should be provided with a protective cover suitable to protect these contacts from damage, contamination, etc. while the unit is installed in the aircraft. The manufacturer should observe ARINC Specification 600 standards for unit projections, etc., when choosing the location for this auxiliary connector.

6.1.1 ATE Testing

The VDR should be designed to be testable using support equipment that complies with ARINC Specification 608A, "Design Guidance for Avionics Test Equipment".

7 PROVISIONS FOR BUILT-IN TEST EQUIPMENT (BITE)

7.1 Introduction

The VDR should contain BITE capabilities in accordance with ARINC Report 624, "Design Guidance for Onboard Maintenance System (OMS)", and Report 604, "Guidance for Design and Use of Built-In Test Equipment."

COMMENTARY

The guidance in ARINC Report 624 regarding the BITE capability for detection and isolation of internal and external VDR faults or failures generally supersedes that in ARINC Report 604. Also, the general philosophy, basic guidance, and certain specific recommendations are described for the OMS in ARINC Report 624, and for the Centralized Fault Display System (CFDS) in ARINC Report 604.

The VDR BITE should be capable of detecting and annunciating a minimum of 95% of the faults or failures which can occur within the VDR and as many faults as possible associated with the VHF antenna, coaxial cable, and interfaces with the CMU or MU.

COMMENTARY

Whether the VSWR of the antenna and its associated cabling should be measured and judged "GOOD" has been a subject of considerable discussion in the past. The antenna cabling loss is specified as not more than 5.5 dB. 5.5 dB yields a VSWR of not more than 1.9:1 regardless of the antenna VSWR. Therefore, measuring the VSWR at the connector of the radio at best only determines whether or not the antenna feed line is connected and not severely damaged near the transceiver. Under no circumstances should an antenna and its associated cabling be judged "BAD" if acceptable communications can be performed.

The VDR BITE should operate continuously during flight. Monitoring of the results should be automatic. The BITE should automatically test, detect, isolate, and record both intermittent and steady state faults.

The BITE should indicate its condition and any faulty inputs upon activation of the self-test routine. In addition, BITE should display faults which have been detected during in-flight monitoring.

COMMENTARY

An example of this would be an internal loopback test which would demodulate and monitor each frame transmitted, in order to verify the correct operation of the transmitter and receiver.

No failure occurring within the BITE subsystem should interfere with the normal operation of the VDR.

COMMENTARY

Sufficient margins should be used in choosing BITE parameters to preclude nuisance warnings. Discrepancies in VDR operation caused by power bus transients, received noise, EMI, servicing interference, abnormal accelerations, turbulence, etc. should not be recorded as faults.

7 PROVISIONS FOR BUILT-IN TEST EQUIPMENT (BITE) (cont'd)

7.2 BITE Interfaces

The VDR should facilitate control and annunciation of the BITE information via the following interfaces:

a. OMS/CFDS Interfaces
b. MU/CMU Interfaces
c. VDR Control Panel

COMMENTARY

The VDR is intended to be compatible with newer aircraft which have either an OMS or CFDS, as well as older aircraft which have no centralized maintenance system. In order to ensure interchangeability of the VDR across the entire range of installations, it should be capable of supporting BITE on the various interfaces.

On the OMS/CFDS interfaces and the MU/CMU interfaces, the VDR should provide a listing of BITE options in menu format for operator selection. By menu selection, the operator should be capable of requesting fault status (current and previous), initiating self tests and requesting detailed failure information for diagnostics. The philosophy expressed in ARINC Reports 604 and 624 is that avionic units such as the VDR should provide an interactive, "user friendly" aid to maintenance.

The ARINC 600 program pins MP11C and MP14A, should be wired as described in Table A8-15 ***herein*** to indicate whether the VDR is connected to an Airbus, Boeing, or McDonnell-Douglas type CFDS.

7.2.1 OMS Interfaces

The VDR should facilitate BITE control and fault reporting capability, including interfaces with single or dual Central Maintenance Computer (CMC) units in accordance with ARINC Report 624. Table ***A***8-1 ***herein*** describes the list of BITE codes which should be used for VDR fault reporting.

7.2.2 Character-Oriented CFDS Interfaces

The VDR should facilitate BITE control and readout, including interfaces with single or dual Centralized Fault Display Interface Units (CFDIUs), in accordance with the character-oriented fault reporting protocol described in ARINC Report 604.

7.2.3 Bit-Oriented CFDS Interfaces

The VDR should facilitate BITE control and readout, including interfaces with single or dual CFDIUs, in accordance with the bit-oriented fault reporting protocol described in ARINC Report 604. Command and Fault summary words should be in accordance with Tables ***A***8-2 and ***A***8-3.

7.2.4 MU/CMU BITE Interfaces

The VDR should facilitate BITE control and readout via the single or dual interfaces with the MU or CMU. Protocols for exchange of BITE data on these interfaces should be in accordance with the bit-

oriented CFDIU protocol described in ARINC Report 604. Command and Fault summary words should be in accordance with Attachment 8, Tables 8-2 and 8-3.

7.3 BITE Presentation

BITE information provided on the data buses for the OMS/CFDS and CMU/MU is to be presented to maintenance personnel on the display contained within the applicable system. Additionally, the VDR should present System/LRU fault status on its front panel in order to facilitate the use of BITE for local troubleshooting in the electronics equipment bay and for installations without a compatible OMS/CFDS or MU/CMU.

COMMENTARY

Airlines desire that BITE information be presented to line maintenance personnel using easily understandable text - not coded! - and using an alpha-numeric display or equivalent technique. The airlines do not want the maintenance personnel to be burdened with carrying a library of code translations, and desire BITE fault analysis capability equal to or surpassing that realized with shop Automatic Test Equipment.

7.4 Fault Monitor

The results of in-flight or ground operations of BITE should be stored in a non-volatile monitor memory. The size of the memory should be sufficient to retain detected faults during the previous ten flight legs. The data in the monitor memory should include flight leg identification and fault description.

The contents of the monitor memory should be retrievable by BITE operation or by shop maintenance equipment. Refer to ARINC Report 624 for further guidance on fault recording.

The VDR should send BITE fault data to the OMS/CFDS and MU/CMU on the applicable Data Bus.

COMMENTARY

The airlines have expressed an interest in having BITE data from as many as 64 previous flight legs available in memory.

A question which should be considered by the equipment designer is, "What is the scope/purpose of BITE?" It appears from the unconfirmed failure data that is available from repair shop operations, that there is merit in considering storage of data which identifies the Shop Replaceable Unit (SRU). BITE should be used to detect and isolate faults to the LRU level.

7.5 Self-Test Initiation

At the time of equipment turn-on, a power-up self-test should be initiated automatically as described in ARINC Reports 604 and 624. In addition, the VDR should provide self-test capability for troubleshooting and installation verification. The initiation of the applicable test sequences should be possible from the control point(s) for the OMS, CFDS, MU, or CMU.

7 PROVISIONS FOR BUILT-IN TEST EQUIPMENT (BITE) (cont'd)

COMMENTARY

It is desirable that the power-up self-test be completed in less than 15 seconds.

As an aid to shop maintenance and local trouble-shooting on the aircraft, a mechanism should be provided on the VDR front panel for initiation and annunciation of a unit/system self-test and results. The self-test routine should start with a test which verifies the correct operation of all elements of the annunciating mechanism. If the self-test routine detects a fault, the appropriate fault should be annunciated. If no fault is found, the contents of the intermittent fault memory should be reviewed; if an occurrence of a fault on one of the four earlier flight legs is detected, the appropriate fault should be annunciated. If no faults are detected, and none were recorded during the four earlier flight legs, a "normal" status should be annunciated. Fault annunciations should continue until the self-test control is activated a second time or a "time-out" period of approximately ten minutes expires.

COMMENTARY

Selection of four as the number of flight legs (for which intermittent fault memory should be examined for the line maintenance BITE function) was made in the belief that it could be reduced as confidence in the BITE was built up. Manufacturers are urged to make this number easily alterable in their BITE implementation.

7.6 Monitor Memory Output

The BITE Monitor Memory output should consist of the following:

a. An output on the applicable ARINC 429 Data bus to the OMS/CFDS or MU/CMU when so requested, as described in ARINC Reports 624 and 604 using the format described therein.

b. An output to the VDR front panel annunciator, indicating the status of the VDR, antenna, coaxial cable, and interfaces. An English language presentation is preferred over coded messages.

c. An output of undefined format which should be made available for shop read-out at the ATE reserved pins of the upper connector located on the VDR.

The monitor memory should be capable of being reset in order that stored faults are not carried over once an LRU replacement or repair has been effected. The reset should be initiated only by shop maintenance.

8 PROVISIONS FOR USER INTERFACES

8.1 Introduction

This Section describes the VDR interfaces with the crew; namely, the control panel, audio and microphone keyline interfaces, and user notification and crew alerting provisions.

COMMENTARY

User notification provisions include positive visual and aural indications of operational conditions in the VDR and in other associated avionics. Certain user notification provisions are associated only with VDLM3 operation. Other user notifications may be provided by closely-associated equipment; e.g., the crew alerting provisions of the CMU (see ARINC 758, Section 5.4.6).

8.2 Control Panels

8.2.1 Control Panel (All Modes Except VDLM3)

COMMENTARY

Guidance on manual frequency control and the "Standard Control Panel" for a VDR capable of supporting only 25 kHz DSB-AM, 8.33 kHz DSB-AM voice and ACARS Mode "0" is given in ARINC 716, Sections 1.3.2 and 2.2.2. Similar guidance has been used for previous VDR control panels.

8.2.2 Radio Tuning Panel (RTP) (All Modes Including VDLM3)

This subsection defines the functional aspects of a "Functional Standard" Radio Tuning Panel (RTP) for a VDR that supports all operational modes defined in Section 3, including VDLM3.

COMMENTARY

The VDR ports interfacing with the RTP also provide the interfaces with the Onboard Maintenance System (OMS) (see Section 7) and to "cross-talk" buses that interconnect multiple VDRs on an aircraft, which interfaces are used for link management, special features available with a VDLM3 system and for control of possible conflicts among multiple radios (see Section 9). Deviation from these definitions may result in incorrect operation or unavailability of these features.

8.2.2.1 RTP Functional Overview

The RTP communicates with a VDR via two ARINC 429 busses. A bus from the RTP to the VDR provides the tuning data, mode commands and requests to the VDR. The OMS/VDR/RTP output bus (formerly, “Data to OMS/CFDS output bus”) from the VDR provides the tuned-to channel (or frequency), tuning uplink data and VDLM3 information to the RTP. The OMS/VDR/RTP bus is required to support the following VDLM3 specific features:

8 PROVISIONS FOR USER INTERFACES (cont'd)

a. Next Channel Uplink, which allows ATS to uplink the next sector frequency or channel to the RTP
b. Urgent Downlink Request (UDR), which enables a pilot to request priority access to the voice channel.

COMMENTARY

There are several optional features that exploit the digital capabilities of the VDLM3 system. The implementation of each feature is based on a number of factors and may impact both the avionics and/or the ground system. This characteristic attempts to incorporate provisions for all of the features, although only a limited number of these may actually be implemented. See RTCA DO-279 for a discussion of contemplated features.

The OMS/VDR/RTP output bus is also required to support master/auxiliary coordination between multiple VDRs during VDLM3 operation. The interface between the RTP and the VDR and between VDRs supports continuous ARINC 429 low speed data transfer, unless otherwise specified.

8.2.2.2 RTP-to-VDR Interface

8.2.2.2.1 ARINC 429 Tuning Words, RTP to VDR

The ARINC 429 tuning word outputs from the RTP to the VDR are described as follows:

Label	*Description*
030	*25 kHz DSB-AM VHF COMM Frequency*
031	*VDLM3 VHF COMM Channel*
047	*8.33 kHz DSB-AM VHF COMM Frequency*

The RTP output Label 030, Label 031 and Label 047 words are defined in Tables A8-18, A8-19 and A8-20, respectively. The transmit intervals for these words in the RTP-to-VDR interface should be bounded by the following minimum and maximum values:

Minimum Interval	*100 ms*
Maximum Interval	*200 ms*

The RTP should stop transmitting this word when a detected failure could cause the data to be unreliable.

Only one of the COMM Frequency/Channel words (Labels 030, 031, or 047) should be sent at a given time, and is dependent on the current mode of operation. Only one COMM Frequency/-Channel word (Label 030, 031 or 047) should be transmitted continuously depending on the VDR mode. The RTP should stop transmitting these words when a detected failure could cause these to be unreliable. The ARINC 429 data contents for frequency/channel encoding are detailed in Table A8-25.

8.2.2.2.2 VDR Mode Command/Request – Label 276

The RTP output Label 276 word is defined in Table A8-21. The transmit interval for the Label 276 word in the RTP-to-VDR interface should be bounded by the following minimum and maximum values:

Minimum Interval	*100 ms*
Maximum Interval	*200 ms*

8.2.2.3 VDR-to-RTP and VDR-to-VDR Interfaces (VDLM3)

The VDR-to-RTP and VDR-to-VDR interfaces are shown in Figure A8-2. The VDR output for these interfaces is the OMS/VDR/RTP port, and the VDR input is the Crosstalk Input. The ARINC 429 words are set by the VDR in accordance with Section 4.5.3, are output by the VDR across these interfaces and are described as follows:

Label	*Description*	*Reference*
050	*Next Channel*	*Table A8-22*
051	*VDLM3 Status*	*Table A8-23*
055	*VDLM3 Information*	*Table A8-24*

COMMENTARY

In addition to containing data used by the RTP to support the user interfaces, the content of these words is also used by the other VDRs in a multiple VDR installation on an aircraft (see Section 9).

The transmit intervals for Label 051 and Label 055 words should be bounded by the following minimum and maximum values:

Minimum Interval	*100 ms*
Maximum Interval	*200 ms*

8.2.2.3.1 ARINC 429 Next Channel Word – Label 050

Data contained in the Next Channel Word is used by the RTP(s) to indicate the next channel for continued VHF service.

Whenever the VDR receives a next channel/frequency uplink message, the VDR should:

a. Set the data as specified in Table A8-22, and

b. Burst the Label 050 word at an interval of 100-200 ms for 2 +/- 0.5 seconds.

8 PROVISIONS FOR USER INTERFACES (cont'd)

8.2.2.3.2 ARINC 429 VDLM3 Status Word – Label 051

Data contained in a Label 051 word is used by the RTP to confirm that its associated VDR is tuned to the channel commanded by the RTP, and to convey the current status of the VDR to the RTP and other VDR(s).

When in VDLM3 operation, the VDR should output the "tuned to" channel via Label 051. The VDR should not transmit Label 051 when a detected failure could cause one or more of these words to be unreliable. When not in VDLM3 operation, the SSM should be set to No Computed Data (NCD).

The transmit intervals for Label 051 words should be bounded by the following minimum and maximum values:

Minimum Interval	***100 ms***
Maximum Interval	***200 ms***

8.2.2.3.3 VDLM3 Information – Label 055

Label 055 words transmitted by the VDR provide the RTP(s) and other VDR(s) with VDR VDLM3 control information.

COMMENTARY

> ***This information may be used by an RTP to support VDLM3 features. It may also be used by other on-board VDRs to support master/auxiliary coordination and VDLM3 feature control.***

The VDR should set the Label 055 SSM (bits 30-31) to Normal Operation or Functional Test when operating in VDLM3. The VDR should set the SSM to NCD, when not operating in VDLM3.

The transmit intervals for Label 055 words should be bounded by the following minimum and maximum values:

Minimum Interval	***100 ms***
Maximum Interval	***200 ms***

8.2.2.3.4 Urgent Downlink Request (UDR) Handling

8.2.2.3.4.1 UDR Capability

The VDR should set the UDR Capability field (bit 24) to Available in its transmitted Label 051 word while the VDR is Logged-in to a VDLM3 ground station whose transmitted Supported Options message indicates that UDR is supported, or while the VDR receives a Label 051 from a

co-channel VDR whose UDR Capability field is set to Available; otherwise this field should be set to Unavailable.

8.2.2.3.4.2 UDR Status Field

Two bits in the Label 051 UDR Status field indicate the progress of the active UDR, and are defined as follows:

26	*25*	*Definition*
0	*0*	*Idle*
0	*1*	*Pending*
1	*1*	*Acknowledged*
1	*0*	*invalid*

A setting of Idle indicates that there is no UDR activity on the channel. A setting of Pending indicates that a UDR has been requested via a RTP, and that the ground station has not yet been notified of that request. A setting of Acknowledged indicates either that the UDR has been sent to the ground in a Poll Response, or that the ground has acknowledged the UDR sent in a Reservation Request.

When the UDR Status is Pending or Acknowledged, it will become Idle upon the occurrence of one of the following events:

a. any VDR on the channel transmits voice,

b. the UDR is cancelled (by the RTP),

c. the VDR is retuned, or

d. the VDR's Logged-in status changes to Not Logged-in.

If the VDR detects that UDR capability is available, and its UDR Status field is set to Idle, then the VDR should set the UDR Status field to Pending within 500 ms of one of the following events:

a. the VDR receives a Label 031 from the RTP whose UDR Request bit changes from Idle to Requested, or

b. the VDR receives a Label 051 from a co-channel VDR whose UDR Status field changes from Idle to Pending.

If the VDR is Master, and its UDR Status field is set to Pending, then the VDR should set the field to Acknowledged within 500 ms of one of the following events:

a. the VDR transmits a UDR to the ground station in a Poll Response message, or

8 PROVISIONS FOR USER INTERFACES (cont'd)

b. the VDR transmits a UDR to the ground station in a Reservation Request message and receives an acknowledgement from the ground station (i.e., a RACK).

If the VDR detects that the ground station is capable of supporting UDR, and the VDR's UDR Status field is set to Idle, then the VDR should set the field to Acknowledged within 500 ms of its receipt of a Label 051 from a co-channel VDR whose UDR Status field changes to Acknowledged.

If the VDR detects that the ground station is capable of supporting UDR, and the VDR's UDR Status field is set to Pending or Acknowledged, then the VDR should set the field to Idle within 500 ms of one of the following events:

a. the VDR begins voice transmission,

b. the VDR receives a Label 031 from the RTP whose UDR Request bit is set to "0" (indicating a cancellation),

c. the VDR receives a Label 051 from a co-channel VDR whose UDR Status field is changes to Idle,

d. the VDR retunes to another channel,

e. the VDR logs out of the network or otherwise changes its Logged-in status to Not Logged-in.

8.3 Receiver Audio Interface

For operation in 25 kHz DSB-AM, the VDR receiver audio interfaces should correspond with recommendations of ARINC 716, Section 3.6.5.

For operation in 8.33 kHz DSB-AM, the VDR receiver interfaces should correspond with applicable recommendations of ARINC 716, Section 4.3.4.

For operation in VDLM3 voice mode, the VDR receiver audio interfaces should correspond with recommendations of ARINC 716, Sections 3.6.5, 3.6.5.1, 3.6.5.2 and 3.6.5.4.

COMMENTARY

> ***In VDLM3 voice operation, the applicability of the recommendations of ARINC 716 Sections 3.6.5.3, 3.6.5.5, 3.6.5.6 and 3.6.5.7 is to be determined.***

8.4 Transmitter Audio, Sidetone and Keyline Interfaces

8.4.1 Transmitter Audio Interface

For operation in 25 kHz DSB-AM, the VDR transmitter audio interfaces should correspond with ARINC 716, Section 3.7.5 and its subsections.

For operation in 8.33 kHz DSB-AM, the VDR transmitter audio interfaces should correspond with applicable recommendations of ARINC 716, Section 4.4.2.

For operation in VDLM3 voice mode, the VDR transmitter audio interfaces should correspond with recommendations of ARINC 716, Section 3.7.5.

COMMENTARY

In VDLM3 voice operation, the applicability of the recommendations of the subsections of ARINC 716, Section 3.7.5, is to be determined.

8.4.2 Transmitter Sidetone

Sidetone of voice transmissions should be mixed into, and shared with, the received voice audio output port, in accordance with ARINC 716, Section 3.7.3.

8.4.3 Transmitter Keyline

COMMENTARY

A keyline determines when the transmitter is to be enabled, either by a push-to-talk (PTT) switch for voice signals, such as from a microphone; or by other automated means when data signals are ready for transmission. In all voice modes, voice transmissions are enabled only when the voice keyline is asserted. In VDLM3 operation, the actual timing of the TDMA transmission bursts containing either data or digitized voice information is controlled automatically by the VDR and system timing; however, system management transmissions will occur automatically regardless of keyline status. See Sections 3.1 and 3.2.

When operating in a voice mode or ACARS Mode 0, the VDR should conform to the recommendations of ARINC 716, Section 3.7.7.

8.5 User Notifications and Alerts (VDLM3)

COMMENTARY

VDLM3 operation provides a number of user features not available in other modes, some of which involve user notifications and alerts to certain conditions. Some additional features have been deferred for future implementation.

8.5.1 Next Channel Uplink

When the VDR is Logged-in to a VDLM3 network, Next Channel Uplink feature is available. The RTP should provide a means for displaying the next frequency/channel information for review by the pilot. The RTP should also provide a means for the pilot to accept/activate the

next frequency/channel information. The acceptance/activation of the next frequency/channel should cause the VDR to re-tune to that frequency/channel.

When multiple VDRs are tuned to the same channel and a Next Channel Uplink is received, each RTP, corresponding to a VDR on the channel, should display the same next frequency/channel information.

The Next Channel Uplink information should be provided to the RTP from the VDR in accordance with Section 0.

8.5.2 Urgent Downlink Request (UDR)

When the VDR is enabled to support VDLM3 Enhanced Voice operation and the ground station supports UDR, UDR capability is available. The RTP should provide a means for the pilot to activate and cancel an UDR. The RTP should also indicate whether UDR support is available and when an UDR is pending.

8.5.3 Transmit Access Denied Indication

When VDLM3 voice transmission is not possible upon PTT assertion (e.g., when the channel is occupied, TDMA synchronization has not yet been achieved), the VDR should output to the Audio Output port a pulsed tone mixed with the received audio for as long as the PTT remains active. The pulsed tone characteristics should be as specified in Section 8.5.6.

COMMENTARY

This feature is available in any avionics configuration; i.e., with a stand-alone VDR.

8.5.4 Transmission Termination Indication

When VDLM3 voice transmission is terminated abruptly while the PTT is active (e.g., ground controller preemption, step-on detection), the VDR should output to the Sidetone/Audio Output port a pulsed tone mixed with the received audio for as long as the PTT remains active. The pulsed tone characteristics should be as specified in Section 8.5.6.

COMMENTARY

This feature is available in any avionics configuration;e.g., with a stand-alone VDR.

8.5.5 Transmit Timeout Warning Indication

When the PTT has been active for 30 +/- 2 seconds, the VDR should output to the Sidetone/Audio Output port a pulsed 1 kHz tone mixed with the sidetone audio for up to 5 seconds. If, after an additional 5 +/-2 seconds, the PTT is still active, the pulsed tone should continue to be mixed with the received audio for as long as the PTT remains active. The pulsed tone characteristics should be as specified in Section 8.5.6.

COMMENTARY

This feature is available in any avionics configuration; e.g., with a stand-alone VDR.

8.5.6 Alerting Pulsed Tone Characteristics

The pulsed tone should consist of a 1 kHz +/- 120 Hz tone alternating ON and OFF at half-second (500 ms +/- 200 ms) intervals. The tone amplitude should be adjustable between 6 to 9 dB below the nominal level of the audio output.

8.6 VDLM3 Aircraft ICAO Address

The VDR should provide the means to receive the 24-bit Aircraft ICAO Address from the aircraft's Mode S Transponders (ARINC Characteristic 718) via two dedicated ARINC 429 Low or High-Speed inputs using pins TP-3C/3D and TP-9C/9D. The VDR should decode the 24-bit ICAO Address from ARINC words with Labels 275 and 276 received at nominal intervals of 200 ms and formatted as specified in ARINC Characteristic 735A, Attachments 6P and 6Q, respectively.

COMMENTARY

Interfaces to two Mode S Transponders are necessary because only one of the transponders may be active at a time.

The 24-bit Aircraft ICAO Address should be acquired from the first valid Label 275/276 pair of words received on either of the two 429 receive ports, either when the VDR is initially powered up or when VDLM3 is initially activated. The ICAO address is deemed to be valid if at least two pairs of Label 275/276 words are received in a 500 ms interval, both labels are present, the address decoded from both words is not zero, and the SSM bits are not set to "Failure Warning (FW)". The ICAO address should be used from when it is initially determined to be valid until the aircraft is on the ground and the primary power is recycled.

COMMENTARY

The ICAO address, once initially determined, will be used across primary power cycling that may occur while the aircraft is in the air. One way of implementing this might be by storing the ICAO address in a non-volatile memory device, to be re-used upon subsequent primary power cycling that may occur in the air. When power is recycled on the ground, the non-volatile memory device can be cleared.

COMMENTARY

It is acceptable to use a non-zero ICAO Address decoded from 429 words with SSM bits set to "No Computed Data (NCD)" for the following reasons. Initially at power up, the Mode S Transponder sets the ICAO Address broadcast in Label 275/276 words to all 0's. After that, it begins broadcasting the correct non-zero address, but the SSM bits are set to

8 PROVISIONS FOR USER INTERFACES (cont'd)

"NCD" as long as the transponder is operating in "standby" mode. Only when the transponder transitions to "operational" status are the SSM bits in the Label 275/276 broadcast words set to "Normal".

The 24-bit Aircraft ICAO Address acquired from the Mode S Transponder should be used when the VDR is operating in VDLM3 as described in Section A12.3.1.2.

9 PROVISIONS FOR MULTIPLE VDR INSTALLATIONS

9.1 Introduction

This Section describes provisions that may be necessary to preclude operational problems that can occur when multiple radios are installed on the same aircraft.

COMMENTARY

Among the potential problems with multiple VHF radio installations, interference from a transmission of a given radio to the reception of other radio(s) can be of concern. Section 4.2.8.6 contains recommendations for mitigation of such interference.

9.2 VDLM3 Operation

This Subsection describes the VDR coordination provisions necessary to preclude the occurrence of certain situations which could affect advanced VDLM3 services (Enhanced Voice Service and Data Service), when multiple VDRs installed on the same aircraft are tuned to the same VDLM3 channel. These situations are related to the requirement for the unique identity of each aircraft as expressed in its ICAO Address, and the need for discrete addressability for advanced communications purposes. There are no such situations that can affect VDLM3 Basic Voice Service.

COMMENTARY

If two or more VDRs on the same aircraft were attempting to utilize Enhanced Voice Service or Data Service when tuned to the same VDLM3 frequency and associated channel(s), the ground station would be unable to distinguish among the individual transmissions from the aircraft. Further, it is possible that the transmissions from the individual VDRs could occur at the same time, resulting in "step-on" collisions from the perspective of receiving stations and therefore no effective communication. Similarly, if discretely-addressed uplink information were received by the multiple VDRs, each would attempt to pass the information onward to its associated user process, possibly resulting in degraded system performance or lost communications. Section 9.2.4 describes examples of such situations, and the efficacy of this Sections' provisions in precluding these problems.

9.2.1 Coordination Among Multiple VDLM3 VDRs

The coordination provisions described below should be implemented in a VDLM3 VDR and its associated RTP that are installed in multiples on the same aircraft.

COMMENTARY

As compared with ARINC Characteristic 750-3, additional wiring between each VDR unit is necessary. See Section 9.2.3.

9 PROVISIONS FOR MULTIPLE VDR INSTALLATIONS (cont'd)

COMMENTARY

Related provisions may be necessary for ATN-compliant data communications. It is anticipated that this issue will be investigated and appropriately addressed in "Specification 63Z", a VDLM3 data document that will be the equivalent of ARINC 631.

9.2.2 Rules for Multiple VDR Coordination

The following are the fundamental rules of system and VDR operation, on which the coordination provisions are based:

a. A discretely-addressed air/ground connection is necessary to support Enhanced Voice and Data communications. When a VDR is in Logged-in status, such a connection exists.

b. An aircraft is uniquely identified by one, and only one, ICAO Address.

c. The VDLM3 ground system associates one, and only one, Local User ID with each logged-in ICAO address.

d. In Data operation, only one VDR tuned to the same VDLM3 channel can be allowed to transmit, and to receive and pass information to its user. This VDR is the designated Master, and other such VDRs are designated as Auxiliary.

COMMENTARY

This is a restriction only for VDLM3 data operation. Multiple voice radios can transmit and receive on the same channel, as long as only one responds to polls.

e. In Enhanced Voice operation, multiple VDRs can transmit and receive on the same frequency and channel; however, only one VDR can be allowed to respond to ground system Poll Requests.

9.2.3 Implementation of Multiple VDR Coordination

Coordination of Multiple VDRs should be implemented by interconnecting the VDRs with dedicated ARINC 429 buses, referred to as cross-talk buses. Each VDR, using data transmitted by the other VDRs on the cross-talk buses, should detect and resolve a potential channel conflict and unambiguously designate only one of the conflicted VDRs as Master, and the other(s) as Auxiliary. The Master VDR should respond to any received Poll Requests while the Auxiliary VDRs should not respond. A Message Sequence Chart illustrating the actions of the provisions of this Section is shown in Figure A8-4.

9.2.3.1 Cross-talk Bus Architecture

Figure A8-2 shows the interconnection of the cross-talk buses in a generic dual VHF Comm installation. In addition to the cross-talk buses, the ICAO address inputs and VDR/RTP

interfaces are shown as these are also needed for the priority resolution procedures. Each VDR has one output and two input cross-talk buses. A VDR's two cross-talk input buses are each connected to the cross-talk output bus from a different VDR. The RTPs provide the Label 031 tuning word to each VDR. The ICAO address is delivered to each VDR in Label 275 and Label 276 words from an interconnected ARINC 718-compatible ATC transponder.

9.2.3.2 Cross-Talk Bus Data

Each VDR unit should broadcast the following three data items on the OMS/VDR/RTP bus:

a. the unit's tuned channel,
b. the unit's Basic/Enhanced Voice status, and
c. the unit's data connectivity status.

The tuned channel information should be set and transmitted by each VDR in a Label 051 word in accordance with Table A8-23. The Basic/Enhanced Voice status and the data connectivity status should be set and transmitted by each VDR in the VDL Service Level Status field of the broadcast Label 051 word in accordance with Table A8-23. Each VDR should set its SDI in the SDI field of both words.

This information should be received by the other VDRs on their Crosstalk Input buses, and be used to detect a channel conflict and to resolve the Master/Auxiliary priority in the event of a conflict.

In addition to the primary data, each of the Label 051 and Label 055 words should also contain the Source/Destination Identifier SDI of the transmitting VDR. Regardless of which input bus the data arrives on, a receiving VDR should determine, by the SDI in the Label 051 and Label 055 words, the source associated with a received word.

COMMENTARY

> ***This is useful because it obviates an installation that would be interconnection specific, wherein the particular input bus on which the data were received would determine the transmitting source identity. Accordingly, from an installation perspective, any VDR's OMS/VDR/RTP output bus may be connected to any of the other VDRs' Cross-talk input buses.***

9.2.3.3 VDR Coordination Procedures

If the VDR is not in Logged-in status, the VDR should set the VDR Service Level Status field in the broadcast Label 051 word to the bit pattern that corresponds to "Basic Voice Only" (see Table A8-23).

As described in Section A12.5.13, if the VDR transmits a DLS_ON.confirm message in response to a DLS_ON.request received from the CMU, then within [500 msec] it should set the VDR

9 PROVISIONS FOR MULTIPLE VDR INSTALLATIONS (cont'd)

Service Level Status field in the broadcast Label 051 word to the bit pattern that corresponds to "Enhanced Voice and Data Initialized" (see Table A8-23).

As described in Section A12.5.14, if the VDR receives a DLS_CONNECTED.indication message from the CMU, then within [500 msec] it should set the VDR Service Level Status field in the broadcast Label 051 word to the bit pattern that corresponds to "Enhanced Voice and Data Operational" (see Table A8-23).

9.2.3.3.1 Channel Conflict Detection

A channel conflict event is defined to occur if multiple Logged-in VDRs are tuned to the same channel.

COMMENTARY

> ***It is assumed that VDLM3 Data communications are always conducted over a channel associated with a VDLM3 Voice channel, thus the reliance on the Voice communication status.***

A VDR should use the content of the Label 031 word received from the RTP, and the Label 051 and Label 055 words received on its cross-talk input buses to determine channel conflicts.

9.2.3.3.2 Master/Auxiliary Resolution

In the event of a detected channel conflict between two or more VDRs in Logged-in status, the unit that is data-connected (whose Service Level Status indicates "Enhanced Voice and Data Initialized" or "Enhanced Voice and Data Operational"), should be designated as the Master, and other units should be designated as Auxiliary. If neither VDR is data-connected, then the VDR with the lowest SDI should be designated Master, and the other units should be designated Auxiliary. Resolution of a detected conflict should be accomplished within [0.7 s].

COMMENTARY

> ***The resolution time is based on the worst-case times required to receive the Label 051 and Label 055 words, to determine the resolution, and to transmit/receive the new Master/Auxiliary assignments.***

If a Logged-in VDR detects no channel conflict then it should assume Master status.

COMMENTARY

> ***It is significant in the rule that two or more Logged-inVDRs are required for the occurrence of a conflict. If two or more VDRs are tuned to the same VDLM3 channel but only one is Logged-in, then by definition no conflict exists and the Logged-in VDR will assume Master status.***

It is possible, however unlikely, that two VDRs could be configured with the same SDI. This condition is not handled by the above priority resolution rule. Whether both VDRs assumed either Master or Auxiliary status in this situation, the effect on the VDRs' operation would ultimately be the same as an undetected channel conflict.

9.2.3.3.3 Master/Auxiliary Behavior

A VDR that has assumed Master status should respond to ground system Poll Request messages. It should also set the Master/Auxiliary Status field (bit 11) in its broadcast Service Level Status word (Label 051) to "1".

A VDR that has assumed Auxiliary status should not respond to ground system Poll Request messages. It should also set the Master/Auxiliary Status field (bit 11) in its broadcast Service Level Status word (Label 051) to "0".

9.2.4 Examples of Conflict Resolution

The following examples illustrate that the priority resolution scheme will work regardless of the sequence in which VDRs are tuned to a common channel. In the operating scenarios that follow, VDR 1's SDI is set to "1" and VDR 2's SDI is set to "2".

In addition to the frequency tuning data received from the RTP, a VDR uses the tuned channel data, the channel status data and the other-VDR(s) status received on its cross-talk bus inputs to determine whether a conflict exists. Thus, a VDR will detect whether another VDR is tuned to its channel and whether that VDR is in Logged-in status. Based on the individual SDI values, the proper assignments for Master and Auxiliary VDR status will be made.

Example 1. VDR 2 is Logged-in , is resident on channel A, has received a Local-User ID and is operating as channel Master. VDR 1 is subsequently tuned to channel A and logs-in. VDR 1 and VDR 2 detect the channel conflict, and according to the priority resolution rule (lowest SDI, no data-connected VDR), designate VDR 1 as Master and VDR 2 as Auxiliary. VDR 1 now assumes the responsibility for responding to Poll Requests.

Example 2. VDR 2 is Logged-in, is resident on channel A, has received a Local-User ID and is operating as channel Master. Additionally, the CMU has established a network connection using VDR 2. VDR 1 is subsequently tuned to channel A and logs-in. VDR 1 and VDR 2 both detect the channel conflict as in example 1, but as VDR 2 is data-connected, VDR 2 continues operation as Master and VDR 1 assumes Auxiliary status.

Example 3. VDR 1 and VDR 2 are Logged-in and are operating on channel A. VDR 1 has the lower SDI and is operating as Master; and VDR 2, as Auxiliary. VDR 1 is subsequently tuned to channel B. VDR 2 detects that the channel conflict condition no longer exists and assumes the role of Master, responding to Poll Requests as required on channel A.

9 PROVISIONS FOR MULTIPLE VDR INSTALLATIONS (cont'd)

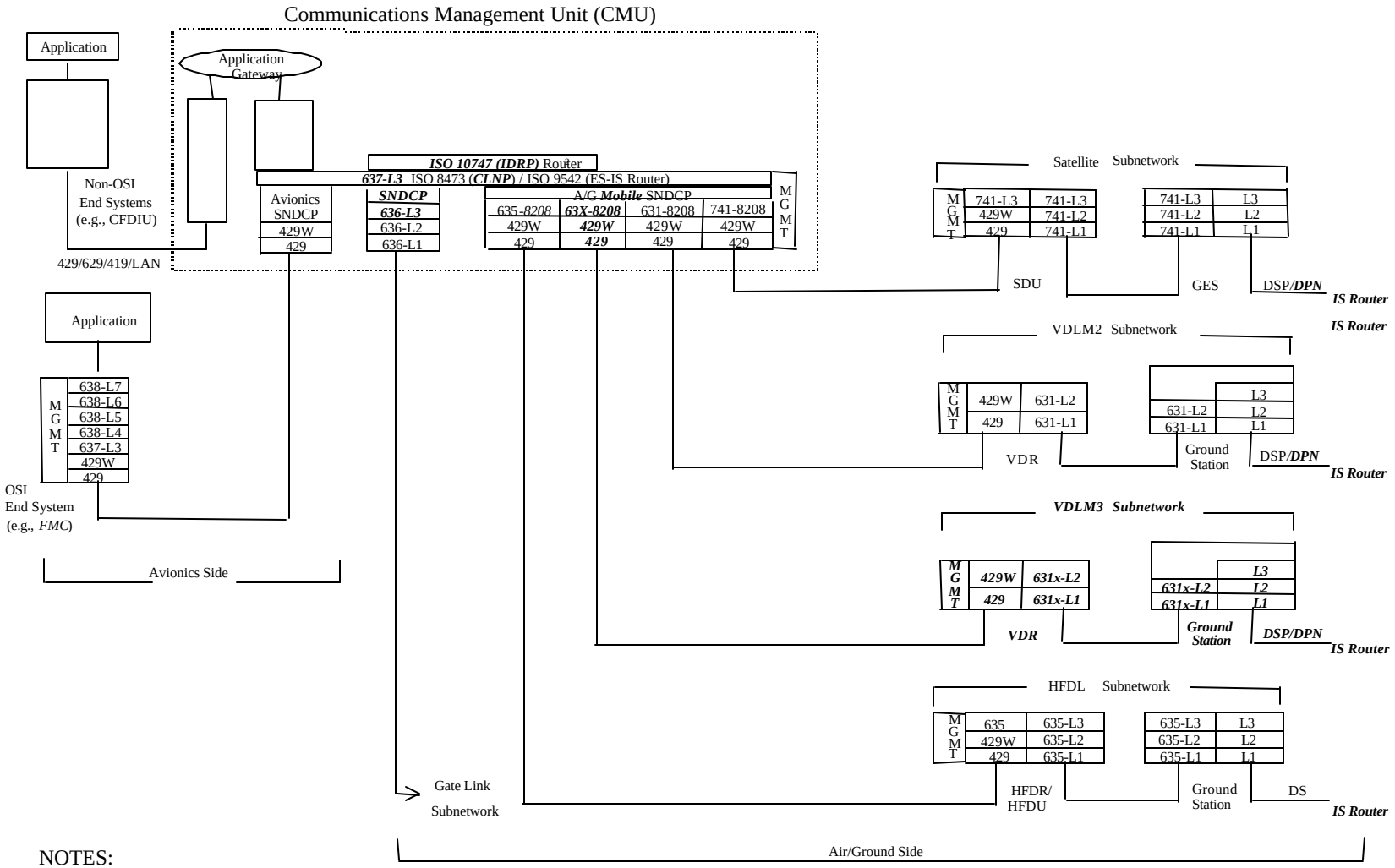
Example 4. VDR 1 is capable of only Basic Voice and tunes to channel A, a channel supporting enhanced Voice service. VDR 2 tunes to channel A and logs-in. As VDR1 is only Basic Voice capable, it cannot be Logged in and no actual conflict exists. VDR 2 assumes Master status.

Example 5. VDR1 is Logged-in and tunes to channel A. VDR 1 attempts a Net_Entry.request but due to system conditions, receives an Aircraft ID of 0 or 61 and assumes Basic Voice operation. VDR 2 subsequently tunes to channel A and logs-in. As VDR 1 is Basic Voice, VDR 2 becomes Master and issues a Net_Entry.request. The Net_Entry.response sent from the ground station contains a valid Aircraft ID. Both VDR 1 and VDR 2 recognize the Aircraft ID. VDR 1 changes to Logged-in status; and due to the lower SDI, assumes Master status. VDR 2 assumes Auxiliary status.

Example 6. Both VDR 1 and VDR 2 are Logged-in and are co-resident on channel A. VDR 1, due to the lower SDI, assumes Master status; and VDR 2, Auxiliary status. Both VDRs indicate to the CMU that data connectivity is available on channel A. The CMU initiates a subnetwork data connection via VDR 2. VDR 2 now assumes Master status and VDR 1 assumes auxiliary status.

9.3 (Reserved for other modes)

****[ed. note: The need for addressing other modes is TBD.]****



NOTES:

1. This figure also appears in other ARINC standards. Due to non-synchronous update of ARINC standards, differences in this figure between standards may arise. In all cases, the figure with the most recent date (see lower left hand corner) should have precedence.
2. Early air-ground links are not likely to support IDRP. IDRP is optional for air-ground links.

02 June 2002 -- updated to include VDLM3 and differences WRT current draft Supplement to 637

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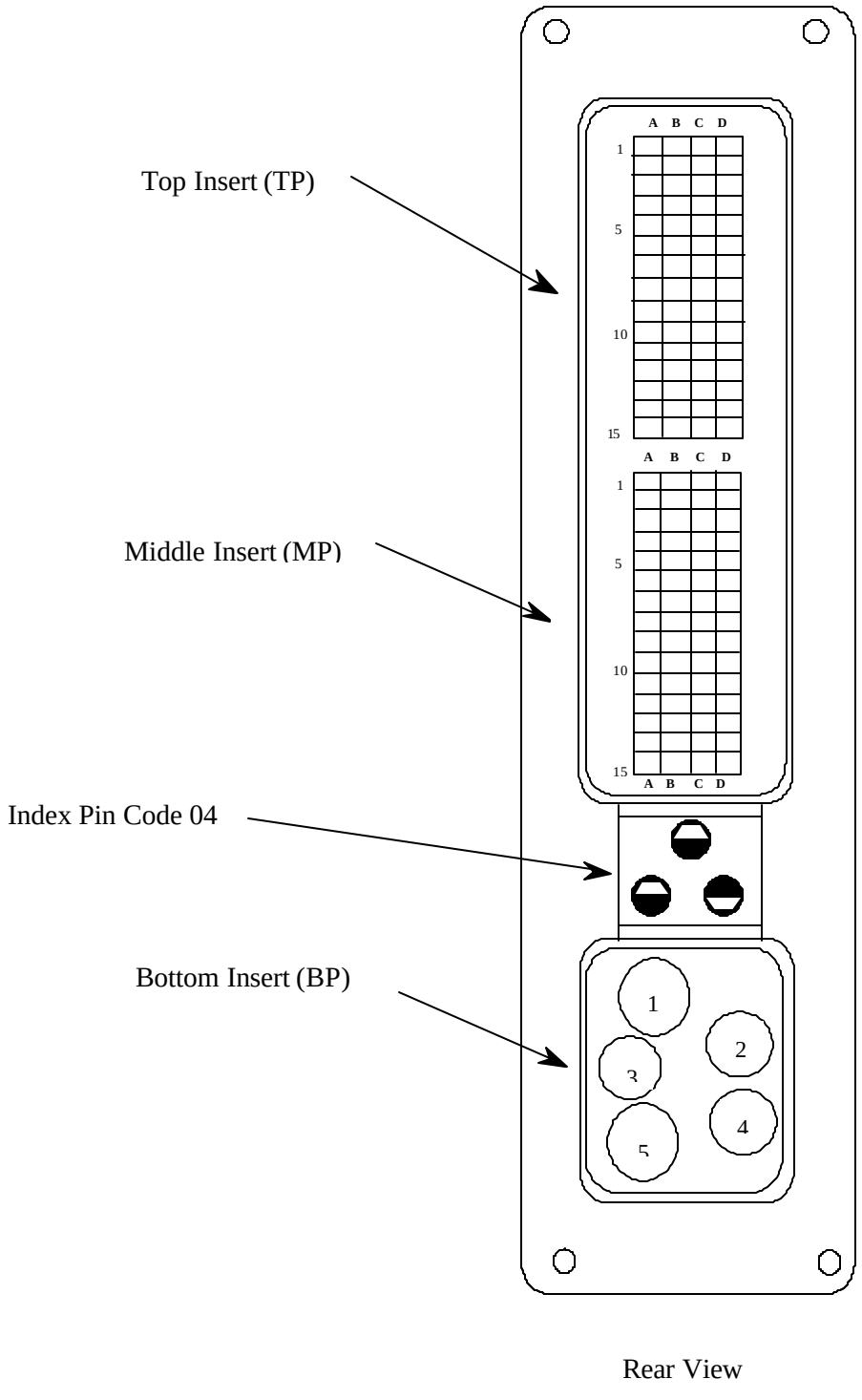
ATTACHMENT 2
VDR CONNECTOR POSITIONING



Rear View

ATTACHMENT 3
STANDARD INTERWIRING

FUNCTION		VDR	CMU#1	CMU#2	OMS	RTP	OTHER	NOTES
Future Spare		TP1A						
Future Spare		TP1B						
Future Spare		TP1C						
Future Spare		TP1D						
Future Spare		TP2A						
Future Spare		TP2B						
Future Spare		TP2C						
Future Spare		TP2D						
VDR Cross-talk	***A***	TP3A	o----------					***5, P***
Input Bus #1	***B***	TP3B	o----------					***5, P***
ICAO Address	***A***	TP3C	o----------					***5, O***
Input Bus #1	***B***	TP3D	o----------					***5, O***
Future Spare		TP4A						
Future Spare		TP4B						
Future Spare		TP4C						
Future Spare		TP4D						
Reserved for ATE		TP5A						
Reserved for ATE		TP5B						
Reserved for ATE		TP5C						
Reserved for ATE		TP5D						
Reserved for ATE		TP6A						
Reserved for ATE		TP6B						
Reserved for ATE		TP6C						
Reserved for ATE		TP6D						
Reserved for ATE		TP7A						
Reserved for ATE		TP7B						
Reserved for ATE		TP7C						
Reserved for ATE		TP7D						
Future Spare		TP8A						
Future Spare		TP8B						
Future Spare		TP8C						
Future Spare		TP8D						
VDR Cross-talk	***A***	TP9A	o----------					***5, P***
Input Bus #2	***B***	TP9B	o----------					***5, P***
ICAO Address	***A***	TP9C	o----------					***5, O***
Input Bus #2	***B***	TP9D	o----------					***5, O***
Future Spare		TP10A						
Future Spare		TP10B						
Future Spare		TP10C						
Future Spare		TP10D						
Future Spare		TP11A						
Future Spare		TP11B						
Future Spare		TP11C						
Future Spare		TP11D						
Future Spare		TP12A						
Future Spare		TP12B						
Future Spare		TP12C						
Future Spare		TP12D						
Future Spare		TP13A						
Future Spare		TP13B						
Future Spare		TP13C						
Future Spare		TP13D						

ATTACHMENT 3 (cont'd)

STANDARD INTERWIRING

FUNCTION		VDR	CMU#1	CMU#2	OMS	RTP	OTHER	NOTES
Future Spare		TP14A						
Future Spare		TP14B						
Future Spare		TP14C						
Future Spare		TP14D						
Future Spare		TP15A						
Future Spare		TP15B						
Future Spare		TP15C						
Future Spare		TP15D						
Mic Input	Hi	MP1A	o					***2, A***
	Lo	MP1B	o					***2, A***
	PTT	MP1C	o					***2, A***
Key Event		MP1D	o					***2, A***
Max Trans Cutoff		MP2A	o					***2, K***
Mic Input (Ground)		MP2B	o					***2***
Data Loader Input	A	MP2C	o					***6, O***
	B	MP2D	o					***6, O***
Optional	Hi	MP3A	o					1, B
(Remote Squelch)	ARM	MP3B	o					1, B
Squelch	Lo	MP3C	o					1, B
dc Ground		MP3D	o					2
Self Test Discrete		MP4A	o					***2***
Audio Ground		MP4B	o					***3***
Data Loader Output	A	MP4C						***4, O***
	B	MP4D						***4, O***
Data Input	Lo	MP5B	o					1, C
Reserved for 716 Compatibility		MP5C	o					
8.33 kHz Program for 716 Compatibility		MP5D						
Data from OMS/CFDS #1 Input Port A	A	MP6A	o		o			2, P
	B	MP6B	o		o			2
Data from OMS/CFDS #2 Input Port B	A	MP6C	o		o			***2, P***
	B	MP6D	o		o			***2***
Frequency/Function Select ***Input*** Port B	A	MP7A	o				o	***3, P***
	B	MP7B	o				o	***3***
Voice Data Select		MP7C	o				o	***2, D***

Data Key Line		MP7D	1, E
Antenna Monitor Program		MP8A	***2***
Data Loader Enable		MP8B	***2, Q***
Reserved for 716 Compatability		MP8C	1
Data Keyline Return		MP8D	1
SDI Code Input		MP9A	2, F
SDI Code Input		MP9B	2, F
Ground		MP9C	2
Reserved for AGC		MP9D	1
Program Common		MP10A	1
Future Spare		MP10B	
Data to both CMUs	A	MP10C	4, O
Output Port	B	MP10D	4

ATTACHMENT 3 (cont'd)
STANDARD INTERWIRING

FUNCTION		VDR	CMU#1	CMU#2	OMS	RTP	OTHER	NOTES
Frequency/Function Select	A	MP11A	o				o	***3, P***
Input Port A	B	MP11B	o				o	***3***
Maintenance System ID		MP11C	o					2
Frequency Input Port Select		MP11D	o				o	2, G
Data from CMU #1	A	MP12A	o	o				4, O
Input Port A	B	MP12B	o	o				4
Data from CMU #2	A	MP12C	o	o				4, O
Input Port B	B	MP12D	o	o				4
SELCAL Audio and	Hi	MP13A	o					1, I
Data Output	Lo	MP13B	o					1, I
Squelch Disable		MP13C	o					1, J
Squelch Disable Return		MP13D	o					1, J
Maintenance System ID		MP14A						2
Ground/Air Discrete		MP14B	o					2, H
Data to OMS/VDR/RTP	A	MP14C	o		o		o	2, P
Output Port	B	MP14D	o		o		o	2
Audio/Sidetone	Hi	MP15A	o					***2***, L
Output	Lo	MP15B	o					***2***, L
Muting		MP15C						***2***, M
Muting Return		MP15D						***2***, M
Antenna RF Input		BP1	o					***2***
Power Input +27.5 Vdc		BP2	o					***2***, N
Spare		BP3						
Power Input Ground		BP4	o					***2***
Not Used		BP5						

ATTACHMENT 4
NOTES APPLICABLE TO STANDARD INTERWIRING

1. ***ARINC 716-defined pins, a***pplicable to ARINC 716 VHF COM compatible operations only.

2. ***ARINC 716-defined pins, a***pplicable to both ARINC 716 VHF COM and ARINC 750 VDR operations. Functions are identical.

3. ***(Reserved)***

4. ARINC 750-defined pins, applicable to ARINC 750 VDR operations only.

5. ARINC 750-defined pins, applicable to VDLM3 operations only.

A. Microphone Input (MP1A, B, C, D)

Standard four wire microphone interwiring as described in Attachment 6 of ARINC Characteristic 716-7. The microphone should be keyed when MP1C is grounded.

B. Optional Remote Squelch (MP3A, B, C)

To accommodate an optional remote squelch adjustment if so required or provided.

C. Data Link Input (MP5A, B)

Analog 2400 bps ACARS data input to the VHF 716 COMM. The interface is defined in ARINC Specification 618.

D. Voice/Data Select (MP7C)

When in ARINC 716-compatible modes, then the VDR is in ***Mode 0*** when pin MP7C is grounded and in ***Voice*** when pin MP7C is open.

E. Data Key Line (MP7D)

When in ***Mode 0***, the transmitter should be keyed when pin MP7D is grounded and should be unkeyed when pin MP7D is open.

F. SDI Code Input (MP9A, B)

An analog discrete pair prewired at the rear connector to identify specific VHF radio location in the aircraft.

G. Data Select Discrete (MP11D)

Used to enable either Frequency/Function Select Data I/P Port A or B. Port A should be selected when pin MP11D is grounded, and port B should be selected when pin MP11D is open.

ATTACHMENT 4 (cont'd)
NOTES APPLICABLE TO STANDARD INTERWIRING

H. Ground/Air Discrete (MP14B)

This discrete is used for BITE functionality. Pin MP14B is grounded to indicate the aircraft is airborne, and is open to indicate the aircraft is on the ground.

I. SELCAL Audio & Data Output (MP13A, B)

An analog output to provide 2400 bps data to the ACARS MU. May also be used for SELCAL provisions.

J. Squelch Disable/Return (MP13C, D)

An analog discrete to provide squelch override or disable capability. The squelch should be disabled when pin MP13C is grounded, and enabled when pin MP13C is open.

K. Maximum Transmission Cutoff Enable (MP2A)

An analog discrete which determines whether the maximum transmission time cutoff feature is implemented. Discrete is open to enable the cutoff feature; if the discrete is grounded, then the cutoff feature is disabled.

L. Audio/Sidetone Output (MP15A, B)

An analog output for either receiver audio during RCV, or sidetone audio during voice transmit modes.

M. Muting/Return (MP15C, D)

An optional two wire analog discrete to provide a switch closure internal to the VHF COMM for external system muting applications during transmit modes. Muting should be enabled when pin MP15C is grounded, and disabled when pin MP15C is open.

N. Power Input (BP2)

One 10 amp circuit breaker should be provided in the standard installation.

O. High Speed ARINC 429 Bus

P. Low Speed ARINC 429 Bus

Q. Data Loader Enable (MP8B)

Discrete to enable Program data loading using ARINC 615 protocols. Pin MP8B is grounded on power up to enable data loading. Voice and data modes are not operational if the Data Loader Enable discrete is grounded on power up.

ATTACHMENT 5
ENVIRONMENTAL CONDITIONS FOR AIRBORNE EQUIPMENT
RTCA/DO-160*D*

The following RTCA/DO-160***D*** categories apply to the environmental specification of the ARINC 750 VHF Digital Radio.

Environment	DO-160D Section	Unit ***and*** Location		
		VDR ***E/E Rack***	***RTP*** ***Flight Deck***	***Antenna*** ***Fuselage Exterior***
Temperature and Altitude	4	***A2***	***A2***	D2
Temperature Variation	5	***B***	***B***	A
Humidity	6	A	A	***B***
Operational Shocks and Crash Safety	7	***B***	***B***	***B***
Vibration	8	***R curve B1***	***R curve B1***	***R curve C1***
Explosion Proofness	9	X	X	***X***
Water Proofness	10	X	X	*R*
Fluids Susceptibility	11	X	X	***F***
Sand and Dust	12	X	X	***S***
Fungus Resistance	13	X	X	F
Salt Spray	14	X	X	S
Magnetic Effect	15	X	X	X
Power Input	16	A	A	A
Voltage Spike	17	A	A	A
Audio Frequency Conducted Susceptibility - Power Inputs	18	Z	Z	Z
Induced Signal Susceptibility	19	***Z***	***Z***	***Z***
Radio Frequency Susceptibility (Radiated and Conducted)	20	***R***	***R***	W
Emission of Radio Frequency Energy	21	***M***	***M***	***H***
Lightning Induced Transient Susceptibility	22	***XXC3***	***XXC3***	***XXXX***
Lightning Direct Effects	23	***X***	***X***	***2A***
Icing	24	X	X	A

ATTACHMENT 6
SIGNAL IN SPACE MASKS

Table A6-1 Spectral Mask of Transmitter for D8PSK

Lower Bound		Upper Bound	
Frequency	**Attenuation**	**Frequency**	**Attenuation**
0	-0.25	0	0.25
1700	-0.25	2500	0.25
3000	-1	3900	-1
3900	-3	4900	-3
4800	-6	5800	-6
5350	-10	6650	-10
6310	-20	7910	-20
6680	-30	8680	-30

Note: Frequency ***deviation*** is specified in Hz from the channel center (on both sides), and the attenuation is specified in dBc.

Table A6-2 Transmitter (D8PSK) -- Adjacent Channel Emission Power Limits

Adjacent Channel (Ordinal)	*Transmitter Output Power Level in Bandwidth around Center Frequency*	
	16 kHz Bandwidth	*25 kHz Bandwidth*
1	***-18 dBm***	***2 dBm***
2	*- - -*	***-28 dBm***
3	*- - -*	***-28 dBm***
4	*- - -*	***-38 dBm***
8	*- - -*	***-43 dBm***
16	*- - -*	***-48 dBm***
32	*- - -*	***-53 dBm***
Greater	*- - -*	***-53 dBm***

Notes:
1. ***"Channels" are spaced at 25 kHz.***
2. ***The limits for adjacent channels beyond the 4th decrease monotonically at a rate of 5 dB per octave.***
3. ***Adjacent channel power includes contributions of discrete spurious signals, primary signal sidebands and noise density (including phase noise).***

Table A6-3 Transmitter (D8PSK) -- General Spurious Emission Limits

Frequency Range	*Power Limit (dBm)*	*Measurement Bandwidth*
9 kHz - 150 kHz	*-36*	*1 kHz*
150 kHz - 30 MHz	*-36*	*10 kHz*
30 MHz - 117.5 MHz	*-36*	*100 kHz*
117.5 MHz - 117.8 MHz	*-36*	*10 kHz*
137.175 MHz - 137.475 MHz	*-36*	*10 kHz*
137.475 MHz - 1 GHz	*-36*	*100 kHz*
1 GHz - 1.7 GHz (see Note 2)	*-60*	*100 kHz*

Notes: 1. Additional spurious emission limits are contained in the text of Section 4.2.8.6.
2. [EUROCAE ED-92A contains this additional specification.]

ATTACHMENT 7
EXAMPLE SYMBOL ENCODING

This attachment was deleted by Supplement 3.

ATTACHMENT 8
VDR TABLES AND FIGURES

Table A8-1 CFDS Fault Identification Codes

Fault Code ID	Nomenclature	Meanings
1	Power Input Recovery	Power interrupt has occurred in the last 3 seconds
2	Left CFDS Activity Fail	No data received from left CFDS
3	Left CFDS Signal Fail	Left CFDS data is invalid
4	Right CFDS Activity Fail	No data received from right CFDS
5	Right CFDS Signal Fail	Right CFDS data is invalid
6	BITE Test Inhibit	Initiated test is inhibited
7	VDR Failure	VDR is in failure
8	VHF Antenna/Coax Failure	VHF antenna or coax is in failure
9	MU/CMU Input-1 Failure	No data received from MU/CMU Input-1
10	MU/CMU Input-2 Failure	No data received from MU/CMU Input-2

Note: Fault ID Codes 1 thru 5 are assigned to generic faults, and Code 6 is assigned to BITE Test Inhibit, based on guidance material in ARINC Report 624.

Staff Note: This table, derived from draft material in Avionics PUB 91-174/FCM-55, may require changes based on work in progress on ARINC Report 624 in the FCM Subcommittee.

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

Table A8-2 *Label 227* -- Bit-Oriented CFDS BITE Command Summary Word Input to VDR

Bit No.	Function	Bit Status	
		1	0
1 2	Label 227 (Octal)		
3 4 5			
6 7 8			
9 10	SDI		
11 12	Pad		
13 14 15 16 17 18 19 20 21 22 23 24	Equipment ID - 016 (Hex)		
25 26 27 28 29 30 31	(See Functional Select Table A7.1 in ARINC Report 604.)		
32	Parity (odd)		

Note: In the event of a conflict between the material in this Attachment and ARINC Report 604, "Guidance for Design and Use of Built-In Test Equipment (BITE)", this Attachment should take precedence.

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

Table A8-3 *Label 350* -- Bit-Oriented CFDS BITE Fault Summary Word Output from VDR

Bit No.	Function	Bit Status	
		1	0
1	Label (350) (Octal)		
2			
3			
4			
5			
6			
7			
8			
9	SDI		
10			
11	VDR Status	Failed	OK
12	Antenna/Coax Status	Failed	OK
13	CFDIU Input Bus 1	Inactive	Active
14	DFS Bus Selection	Port A	Port B
15	Selected DFS Input Bus	Inactive	Active
16	CFDIU Input Bus 2	Inactive	Active
17	CMU/MU Input Bus 1	Inactive	Active
18	CMU/MU Input Bus 2	Inactive	Active
19	***VDR Cross-talk Input Bus 1***	***Inactive***	***Active***
20	***VDR Cross-talk Input Bus 2***	***Inactive***	***Active***
21	***ICAO Address Input Bus 1***	***Inactive***	***Active***
22	***ICAO Address Input Bus 2***	***Inactive***	***Active***
23	***Non-Selected DFS Input Bus***	***Inactive***	***Active***
24			
25			
26			
27	8.33 kHz Tuning Capable	Capable	Not Capable
28	BITE Test Inhibit	Inhibit	Enable
29	Command Word Acknowledge	ACK	NAK
30	SSM		
31			
32	Parity (Odd)		

Note: In the event of a conflict between the material in this Attachment and ARINC Report 604, "Guidance for Design and Use of Built-In Test Equipment (BITE)", this Attachment should take precedence.

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

Table A8-4 VDR Mode Command

[Table A8-4 has been superseded by the Table *A8-21*]

Table A8-5 (Reserved)

Table A8-6 (Reserved)

Table A8-7 *Label 172* -- VDR System Address Label (SAL) Word

Bit	Function	Comments	
1-8	Label 172 (octal)		
9-16	SAL	SDI ***0*** 1 2 3	SAL ***250 octal*** 251 octal 252 octal 253 octal
17	ACARS Mode A, BOP Version 1	1 = not supported, 0 = supported	
18	ACARS Mode A, BOP Version 3	0 = not supported, 1 = supported	
19	VDL Mode 2	0 = not supported, 1 = supported	
20	VDL Mode 3	0 = not supported, 1 = supported	
21	VDL Mode 4	0 = not supported, 1 = supported	
22	Reserved for VDL future mode	0 = not supported, 1 = supported	
23	Reserved for VDL future mode	0 = not supported, 1 = supported	
24	Reserved for VDL future mode	0 = not supported, 1 = supported	
25-29	Pad	Set to zero	
30-31	SSM	***see Table A8-11***	
32	Parity	***odd parity***	

Note: If bits 17-23 are all zero then the VDR may or may not support ACARS Mode A using BOP Version 1 because this feature was introduced after the initial implementation of ACARS Mode A.

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

Table A8-8 *Label 270* -- VDR Status Word, VDR Output

Bit	Function	Comments
1-8	Label 270 (octal)	***VDR Status Word***
9-10	SDI	see Table A8-12
11	***Download Request Bit***	***see Section 5.5.2.3***
12	***DLS Enable bit***	***see Section 5.5.2.11***
13	Transmission Time-out warning bit	Set to "1" if less than 5 seconds until time-out (or timed out). Set to "0" at all other times.
14	***Protocol Status bit***	***see Section 5.5.2.2***
15-16	Primary CMU	16 15 Description 0 0 Single CMU 0 1 Left CMU 1 0 Right CMU 1 1 Undefined (bits 15 & 16 map to bits 9 & 10 in the CMU's Label 270 word)
17	Voice/Data Status bit	Voice = 1
18	VDR Status bit	Fault = 1
19	***CMD Status*** Bit	1 = CMU_STATUS state is CMD
20	PAD	Set to zero
21-24	***CMU/VDR Interface State (Table 3-2)***	24 23 22 21 Description 0 0 0 1 State S1 (1h) 0 0 1 0 State S2 (2h) 0 0 1 1 State S3 (3h) 0 1 0 0 State S4 (4h) 0 1 0 1 State S5 (5h) 0 1 1 0 State S6 (6h) 0 1 1 1 State S7 (7h) 1 0 0 0 State S8 (8h)
25-27	***Active Air-Ground Protocol***	27 26 25 Description 0 0 0 Init State, DSB-AM Voice or ACARS Mode 0 (see Note 1) 0 0 1 ACARS Mode A 0 1 0 VDL Mode 2 0 1 1 VDL Mode 3 1 0 0 VDL Mode 4 1 0 1 mode indicated by bit 22 of VDR Label 172 1 1 0 mode indicated by bit 23 of VDR Label 172 1 1 1 mode indicated by bit 24 of VDR Label 172
28-29	***VDLM3 Data Service Status***	***29 28 Description*** ***0 0 Not Entered Net – Services Unknown*** ***0 1 Entered Net – Data Services not Available (e.g., 4V system configuration)*** ***1 0 Not Entered Net – Data Services Available*** ***1 1 Entered Net – Data Services Available***
30-31	SSM	see Table A8-11
32	Parity	odd parity

Note: 1. VDRs compliant with ARINC 750-2, or earlier, may set bits 25-27 to 0 when in ACARS Mode A.

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

Table A8-9 *Label 377* -- VDR Equipment ID Word, VDR Output

Bit	Function	Comments
1-8	Label 377 (octal)	
9-10	SDI	
11-22	Equipment Class	016_h
23-29	PAD	zero
30-31	SSM Code	Normal (00_h)
32	Parity (odd)	

Table A8-10 System Address Label Field

SDI Strapping		***SAL (octal)***	***Bit 16***	***Bit 15***	***Bit 14***	***Bit 13***	***Bit 12***	***Bit 11***	***Bit 10***	***Bit 9***
MP9A	***MP9B***									
Open	***Open***	***250***	***0***	***0***	***0***	***1***	***0***	***1***	***0***	***1***
Open	***Gnd***	***251***	***1***	***0***	***0***	***1***	***0***	***1***	***0***	***1***
Gnd	***Open***	***252***	***0***	***1***	***0***	***1***	***0***	***1***	***0***	***1***
Gnd	***Gnd***	***253***	***1***	***1***	***0***	***1***	***0***	***1***	***0***	***1***

Table A8-11 Sign Status Matrix Setting

SSM Setting	Bit 31	Bit 30
Normal	0	0
NCD	0	1
Functional Test	1	0
Failure Warning	1	1

Table A8-12 *VDR* SDI Field

SDI Strapping		***SDI Code***	***VDR SDI Field***	
MP9A	***MP9B***		***Bit 10***	***Bit 9***
Open	***Open***	***0***	***0***	***0***
Open	***Gnd***	***1***	***0***	***1***
Gnd	***Open***	***2***	***1***	***0***
Gnd	***Gnd***	***3***	***1***	***1***

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

Table A8-13 Protocol ID, EGFI and EID codes

Protocol	Protocol ID code	EGFI code	EID code
ASIP	$F1_h$	$F1_h$	1_h
ACARSIP	$F2_h$	$F2_h$	2_h
V3SIP	$\boldsymbol{F3_h}$	$\boldsymbol{F3_h}$	$\boldsymbol{3_h}$
ERROR	FF_h	n/a	n/a

Note: The error Protocol ID code is returned in a PR_SET.confirm message when the VDR does not support a protocol requested by the CMU in a PR_SET.request message.

Table A8-14 [C]MU/VDR Command and Control Primitives

Command and Control Message	Primitive	Sender	Type	PID
Error indication	ERROR.indication	either	SOLO	00_h
Protocol set request	PR_SET.request	[C]MU	SOLO	01_h
Protocol set confirm	PR_SET.confirm	VDR	SOLO	01_h
Protocol query request	PR_QUERY.request	[C]MU	SOLO	02_h
Protocol query confirm	PR_QUERY.confirm	VDR	File	02_h
BITE request	VDR_BITE.request	[C]MU	SOLO	03_h
BITE confirm	VDR_BITE.confirm	VDR	File	03_h
Mode set request	MODE_SET.request	[C]MU	SOLO	05_h
Mode set confirm	MODE_SET.confirm	VDR	SOLO	05_h

Table A8-15 Maintenance System Identification

MP11C	MP14A	CFDS Type
Ground	Ground	Airbus CFDS
Ground	Open	Boeing CFDS
Open	Ground	McDonnell-Douglas CFDS
Open	Open	Undefined

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

Table A8-16 Variables of High Speed Bit-Oriented Protocol - Version 1

TIME	DESCRIPTION	MIN VALUE	MAX VALUE	TIMER OR DESIGN GOAL FOR SOURCE OR SINK
T_1	CTS/NCTS Send Time	0 ms	55 ms	Goal for Sink
T_2	RTS Repeat Time After Receipt of NCTS	100 ms	140 ms	Timer for Source
T_3	Busy Send Time	0 ms	100 ms	Goal for Sink
T_4	RTS Repeat Time After Receipt of Busy	1.0 sec	1.2 sec	Timer for Source
T_5	RTS Repeat Time If No Response	150 ms	200 ms	Timer for Source
T_6	Time of Random Timer to Resolve RTS Conflicts	50 ms	500 ms	Goal for Source
T_7	Increment of Time T_6	10 ms	100 ms	Goal for Source
T_8	ACK/NAK/SYN Send Time	0 ms	55 ms	Goal for Sink
T_9	LDU Time-out Following CTS	400 ms	440 ms	Timer for Sink
T_{10}	ACK/NAK Time-out After CTS	600 ms	660 ms	Timer for Source
T_{11}	Loop Back Send Time	0 ms	100 ms	Goal for Sink
T_{12}	ALO Repeat Time if No Response to ALO	200 ms	250 ms	Timer for Source
T_{13}	SOT Send Time After Receipt of CTS	0 ms	55 ms	Goal for Source
T_{14}	Incomplete File Time-out	10 sec	11 sec	Timer for Sink
T_{15}	ALR Send Time	0 ms	180 ms	Goal for Sink
T_{16}	ACK/NAK Time-out After EOT	220 ms	330 ms	Timer for Source

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

Table A8-17 (*RESERVED)*

Table A8-18 Label 030 - 25 kHz DSB-AM VHF COMM Frequency, RTP Output

Bit	*Function*	*Comments*
1-8	*Label 030*	*25 kHz DSB-AM VHF COMM Frequency*
9-10	*SDI*	*10 9 Description* *0 1 VHF-1,* *1 0 VHF-2* *1 1 VHF-3* *0 0 All-call (for dedicated panels)* *See note [4]*
11-14	*0.001 MHz BCD digit*	*Bit 11 is LSB, see note [1]*
15-18	*0.01 MHz BCD digit*	*Bit 15 is LSB, see note [2]*
19-22	*0.1 MHz BCD digit*	*Bit 19 is LSB*
23-26	*1 MHz BCD digit*	*Bit 23 is LSB*
27-29	*10 MHz BCD digit*	*Bit 27 is LSB, see note [3]*
30-31	*SSM*	*31 30 Description* *1 1 Invalid* *1 0 Functional Test* *0 1 No Computed Data (NCD)* *0 0 Normal Operation*
32	*Parity*	*Odd*

Notes:
1. *Only BCD values of 0 or 5 are allowed.*
2. *Only BCD values of 0, 2, 5, or 7 are allowed.*
3. *Only BCD values of 1, 2, or 3 are allowed.*
4. *See Table A8-12 for VDR SDI encoding. The RTP strapping to establish the SDI encoding is not standardized.*

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

Table A8-19 Label 031 – VDL Mode 3 VHF COMM Channel, RTP Output

Bit	*Function*	*Comments*
1-8	*Label 031*	*VDL Mode 3 VHF COMM Channel*
9-10	*SDI*	*10 9 Description* *0 1 VHF-1(L)* *1 0 VHF-2(R)* *1 1 VHF-3(C)* *0 0 All-call (for dedicated panels)* *See note [3]*
11-14	*TDMA Slot*	*14 13 12 11 Description* *0 0 0 1 Slot A* *0 0 1 0 Slot B* *0 0 1 1 Slot C* *0 1 0 0 Slot D* *See note [1]*
15-18	*0.01 MHz BCD digit*	*Bit 15 is LSB*
19-22	*0.1 MHz BCD digit*	*Bit 19 is LSB*
23-26	*1 MHz BCD digit*	*Bit 23 is LSB*
27-29	*10 MHz BCD digit*	*Bit 27 is LSB, see note [2]*
30-31	*SSM*	*31 30 Description* *1 1 Invalid* *1 0 Functional Test* *0 1 No Computed Data (NCD)* *0 0 Normal Operation*
32	*Parity*	*Odd*

Notes:
1. *Other values are not allowed.*
2. *Only BCD values of 1, 2, or 3 are allowed.*
3. *See Table A8-12 for VDR SDI encoding. The RTP strapping to establish the SDI encoding is not standardized.*

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

Table A18-20 Label 047 - 8.33 kHz DSB-AM VHF COMM Channel, RTP Output

Bit	*Function*	*Comments*
1-8	*Label 047*	*8.33 kHz DSB-AM VHF COMM Channel*
9-10	*SDI*	*10 9 Description* *0 1 VHF-1(L)* *1 0 VHF-2(R)* *1 1 VHF-3(C)* *0 0 All-call (for dedicated panels)* *(See note 3)*
11-14	*0.001 MHz BCD digit*	*Bit 11 is LSB, see note [1]*
15-18	*0.01 MHz BCD digit*	*Bit 15 is LSB, see note [1]*
19-22	*0.1 MHz BCD digit*	*Bit 19 is LSB*
23-26	*1 MHz BCD digit*	*Bit 23 is LSB*
27-29	*10 MHz BCD digit*	*Bit 27 is LSB, see note [2]*
30-31	*SSM*	*31 30 Description* *1 1 Invalid* *1 0 Functional Test* *0 1 No Computed Data (NCD)* *0 0 Normal Operation*
32	*Parity*	*Odd*

Notes:
1. *The ARINC 429 word contents are defined in ARINC Characteristic 716 "Airborne VHF Communications Transceiver."*
2. *Only BCD values of 1, 2, or 3 are allowed.*
3. *See Table A8-12 for VDR SDI encoding. The RTP strapping to establish the SDI encoding is not standardized.*

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

Table A8-21 Label 276 – VDR Mode Command/Request, RTP Output

Bit	*Function*	*Comments*
1-8	*Label 276*	*VDR Mode Command/Request*
9-10	*SDI*	*Set to 00 (all-call)*
11	*VHF-1 Voice/Data Command*	*Data = 1, Voice = 0*
12	*VHF-2 Voice/Data Command*	*Data = 1, Voice = 0*
13	*VHF-3 Voice/Data Command*	*Data = 1, Voice = 0*
14-29	*Reserved*	
30-31	*SSM*	*31 30 Description* *1 1 Invalid* *1 0 Functional Test* *0 1 No Computed Data (NCD)* *0 0 Normal Operation*
32	*Parity*	*Odd*

Notes: Any unused (reserved or spare) bits, which are not defined to a specific value, should be defaulted to a value of 0.

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

Table A8-22 Label 050 – Next Channel, VDR Output

Bit	*Function*	*Comments*
1-8	*Label 050*	*Next Channel*
9-10	*SDI*	*10 9 Description* *0 1 VHF-1(L)* *1 0 VHF-2(R)* *1 1 VHF-3(C)* *0 0 Unused* *(See note 1)*
11	*Next Net (Channel) Type*	*0 = DSB-AM ; 1 = VDLM3 (see note 2)*
12-13	*Next Channel (Group ID)*	*12 13 DSB-AM type Frequency (MHz)* *0 0 25 kHz channel X* *0 1 8.33 kHz channel X* *1 0 8.33 kHz channel X + 0.00833* *1 1 8.33 kHz channel X + 0.01666* *or* *12 13 VDLM3 Group (Slot) ID Frequency (MHz)* *0 0 A X* *0 1 B X* *1 0 C X* *1 1 D X* *(See note 3))*
14-23	*Frequency Field*	*binary encoded as 40 (X – 112) where X is the frequency in MHz (bit 14 is MSB and bit 23 is LSB)* *(see note 4)*
24-29	*Reserved*	
30-31	*SSM*	*31 30 Description* *1 1 Normal Operation (NORM)* *1 0 Functional Test* *0 1 No Computed Data (NCD)* *0 0 Failure Warning*
32	*Parity*	*Odd*

Notes:
1. *See Table A8-12 for VDR SDI encoding. The RTP strapping to establish the SDI encoding is not standardized.*
2. *Set equal to bit 37 (bit 5 of 5th octet) in the VDLM3 48-bit Next Net uplink M-burst Message.*
3. *Bit 12 is set equal to bit 25 (bit 1 of 4th octet) and bit 13 is set equal to bit 26 (bit 2 of 4th octet) in the 48-bit Next Net uplink M-burst VDL 3Message.*
4. *Bit 14 is set equal to bit 27 (bit 3 of 4th octet) and bit 23 is set equal to bit 36 (bit 4 of 5th octet) in the 48-bit Next Net uplink M-burst VDL 3Message.*

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

Table A8-23 Label 051 – VDL Mode 3 Status, VDR Output

Bit	*Function*	*Comments*
1-8	*Label 051*	*VDL Mode 3 Status*
9-10	*SDI*	*10 9 Description* *0 1 VHF-1(L)* *1 0 VHF-2(R)* *1 1 VHF-3(C)* *0 0 Unused* *(See note 1)*
11	*Master / Auxiliary Status*	*Auxiliary = 0; Master = 1 (See Section 9.2.3.3.3)*
12-13	*VDLM3 Slot*	*13 12 Description* *0 0 Slot A* *0 1 Slot B* *1 0 Slot C* *1 1 Slot D*
14-23	*Frequency Field*	*binary encoded as 40 (X – 112) where X is the frequency in MHz (bit 14 is MSB and bit 23 is LSB)*
24	*UDR Capability*	*Unavailable = 0; Available = 1 (See Section 8.2.2.3.2.1)*
25-26	*UDR Status*	*26 25 Description* *0 0 Idle* *0 1 Pending* *1 1 Acknowledged* *1 0 invalid (reserved)* *(see Section 8.2.2.3.2.2)*
27-29	*VDR Service Level Status*	*29 28 27 Description* *0 0 0 Not Initialized (TS0)* *0 0 1 Basic Voice (TS1)* *0 1 0 Truncated Basic Voice (TS2)* *0 1 1 Free-running Basic Voice (TS3)* *1 0 0 Enhanced Voice (TS1)* *1 0 1 Enhanced Voice and Data Initialized (TS1)* *1 1 0 Enhanced Voice and Data Operational (TS1)* *1 1 1 Invalid Voice Channel (TS0)* *(See Section [TBD])*
30-31	*SSM*	*31 30 Description* *1 1 Normal Operation (NORM)* *1 0 Functional Test* *0 1 No Computed Data (NCD)* *0 0 Failure Warning*
32	*Parity*	*Odd*

Note: See Table A8 -12 for VDR SDI encoding. The RTP strapping to establish the SDI encoding is not standardized.

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

Table A8-24 Label 055 – VDL Mode 3 Information, VDR Output

Bit	*Function*	*Comments*
1-8	*Label 055*	*VDL Mode 3 Information*
9-10	*SDI*	*10 9 Description* *0 1 VHF-1(L)* *1 0 VHF-2(R)* *1 1 VHF-3(C)* *0 0 Unused* *(See note 2)*
11-13	*Reserved*	
14-17	*Reserved (Ground Signal Quality Indicator)*	*17 16 15 14 Description* *0 0 0 0 Poorest Signal Quality* . . . . . . *1 1 1 1 Best Signal Quality* *See Section 4.3.5*
18-19	*Ground Transmit ID*	*19 18 Description* *0 0 Idle* *0 1 Ground transmission* *1 0 Aircraft transmission* *1 1 Not Used* *(indicates source of received sequence of voice bursts)*
20-22	*Ground Contact Indicator*	*Bit 22 is the LSB (ground station code of last received M-burst uplink or 000 when in TS0 prior to Net Initialization)*
23-29	*Reserved*	
30-31	*SSM*	*31 30 Description* *1 1 Failure Warning* *1 0 Functional Test* *0 1 No Computed Data (NCD)* *0 0 Normal Operation*
32	*Parity*	*Odd parity*

Notes:
1. *Any unused (reserved or spare) bits, which are not defined to a specific value, should be defaulted to a value of 0.*
2. *See Table A8-12 for VDR SDI encoding. The RTP strapping to establish the SDI encoding is not standardized.*
3. *Refer to RTCA DO-279 for definitions of Ground Contact Indicator and Ground Transmit ID.*

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

Table A8-25 VDR Frequency/Channel Encoding Information

Frequency (MHz)	*Channel Spacing (kHz)*	*Control Panel Indication (Channel Name)*	*429 Label Transmitted by Control Panel*	*Mode*	*ARINC 429 Word Content*
118.0000	*25*	*118.000*	*030*	*25 kHz AM*	*18.000*
118.0000	*25-A*	*118.001*	*031*	*VDLM3 / Slot A*	*18.001*
118.0000	*25-B*	*118.002*	*031*	*VDLM3 / Slot B*	*18.002*
118.0000	*25-C*	*118.003*	*031*	*VDLM3 / Slot C*	*18.003*
118.0000	*25-D*	*118.004*	*031*	*VDLM3 / Slot D*	*18.004*
118.0000	*8.33*	*118.005*	*047*	*8.33 kHz AM*	*18.000*
118.0083	*8.33*	*118.010*	*047*	*8.33 kHz AM*	*18.008*
118.0167	*8.33*	*118.015*	*047*	*8.33 kHz AM*	*18.017*
118.0250	*25-A*	*118.021*	*031*	*VDLM3 / Slot A*	*18.021*
118.0250	*25-B*	*118.022*	*031*	*VDLM3 / Slot B*	*18.022*
118.0250	*25-C*	*118.023*	*031*	*VDLM3 / Slot C*	*18.023*
118.0250	*25-D*	*118.024*	*031*	*VDLM3 / Slot D*	*18.024*
118.0250	*25*	*118.025*	*030*	*25 kHz AM*	*18.025*
118.0250	*8.33*	*118.030*	*047*	*8.33 kHz AM*	*18.025*
118.0333	*8.33*	*118.035*	*047*	*8.33 kHz AM*	*18.033*
118.0417	*8.33*	*118.040*	*047*	*8.33 kHz AM*	*18.042*
118.0500	*25*	*118.050*	*030*	*25 kHz AM*	*18.050*
118.0500	*25-A*	*118.051*	*031*	*VDLM3 / Slot A*	*18.051*
118.0500	*25-B*	*118.052*	*031*	*VDLM3 / Slot B*	*18.052*
118.0500	*25-C*	*118.053*	*031*	*VDLM3 / Slot C*	*18.053*
118.0500	*25-D*	*118.054*	*031*	*VDLM3 / Slot D*	*18.054*
118.0500	*8.33*	*118.055*	*047*	*8.33 kHz AM*	*18.050*
118.0583	*8.33*	*118.060*	*047*	*8.33 kHz AM*	*18.058*
118.0667	*8.33*	*118.065*	*047*	*8.33 kHz AM*	*18.067*
118.0750	*25-A*	*118.071*	*031*	*VDLM3/ Slot A*	*18.071*
118.0750	*25-B*	*118.072*	*031*	*VDLM3 / Slot B*	*18.072*
118.0750	*25-C*	*118.073*	*031*	*VDLM3 / Slot C*	*18.073*
118.0750	*25-D*	*118.074*	*031*	*VDLM3 / Slot D*	*18.074*
118.0750	*25*	*118.075*	*030*	*25 kHz AM*	*18.075*
118.0750	*8.33*	*118.080*	*047*	*8.33 kHz AM*	*18.075*
118.0833	*8.33*	*118.085*	*047*	*8.33 kHz AM*	*18.083*
118.0917	*8.33*	*118.090*	*047*	*8.33 kHz AM*	*18.092*
118.1000	*25*	*118.100*	*030*	*25 kHz AM*	*18.100*
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
136.9750	*25-A*	*136.971*	*031*	*VDLM3/ Slot A*	*36.971*
136.9750	*25-B*	*136.972*	*031*	*VDLM3 / Slot B*	*36.972*
136.9750	*25-C*	*136.973*	*031*	*VDLM3 / Slot C*	*36.973*
136.9750	*25-D*	*136.974*	*031*	*VDLM3 / Slot D*	*36.974*
136.9750	*25*	*136.975*	*030*	*25 kHz AM*	*36.975*
136.9750	*8.33*	*136.980*	*047*	*8.33 kHz AM*	*36.975*
136.9833	*8.33*	*136.985*	*047*	*8.33 kHz AM*	*36.983*

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

136.9917	***8.33***	***136.990***	***047***	***8.33 kHz AM***	***36.992***

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

Table A8-26 Near-Term VDLM3 Voice Service Features

Feature	*Service Level*	*Description*
Controller Override	*Basic and Enhanced*	*Controller capability to preempt other users to obtain access to the communication channel*
		Clears aircraft radio "stuck microphone" transmission
Next-Channel Uplink	*Enhanced*	*Next channel sent to aircraft radio*
		Displayed on Radio Tuning Panel for activation by pilot
		Reduces pilot workload and chance of frequency entry errors
Service-Level Status	*Basic and Enhanced*	*Provides pilot capability to perceive limited radio operations*
		Indicates if only Basic Voice Service available
Transmit Status Indicator	*Basic and Enhanced*	*Indicates if pilot's attempt to communicate failed*
		Indicates over-ride by controller
Urgent Downlink Request	*Enhanced*	*Capability for pilot to request priority access to the channel*
		Controller then grants request based on controller discretion

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

(Reserved)

Figure A8-1 (Reserved)

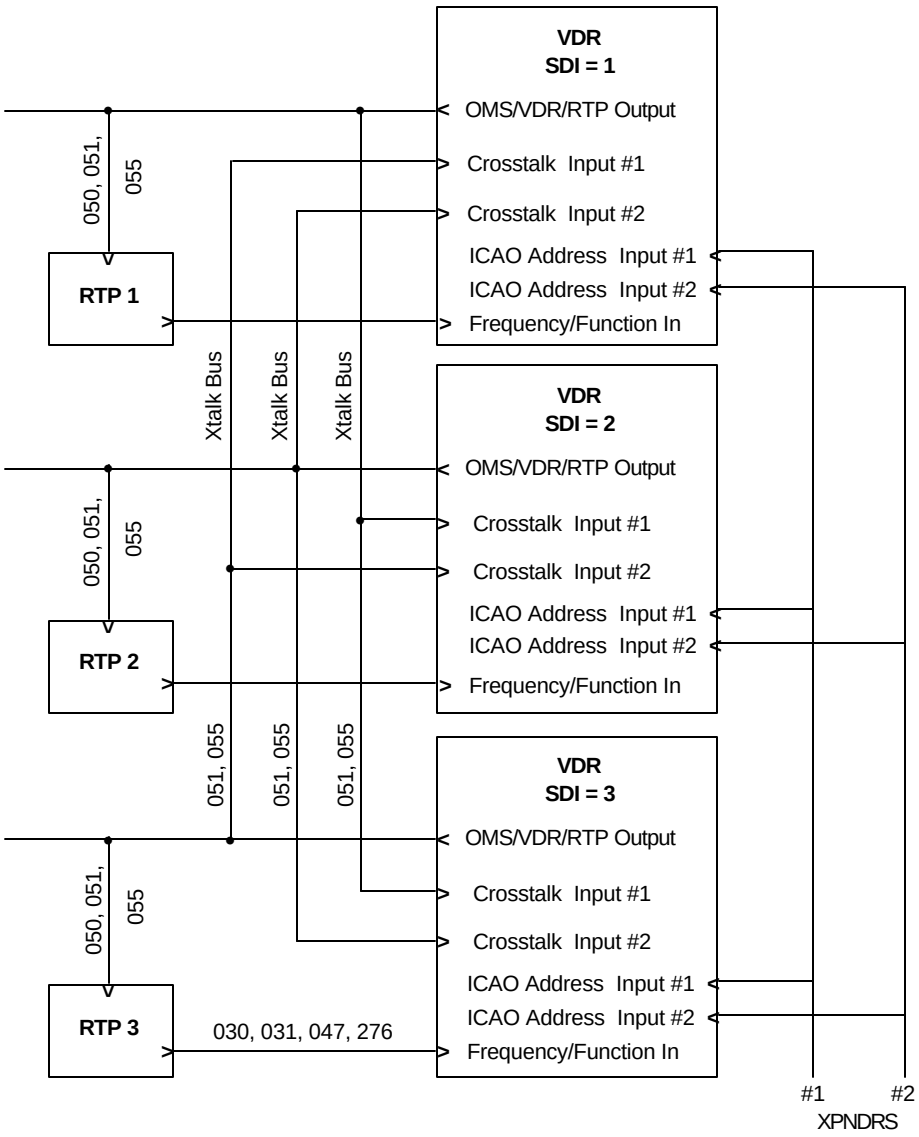


Figure A8-2 Generic Duplex Cross-talk Configuration

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

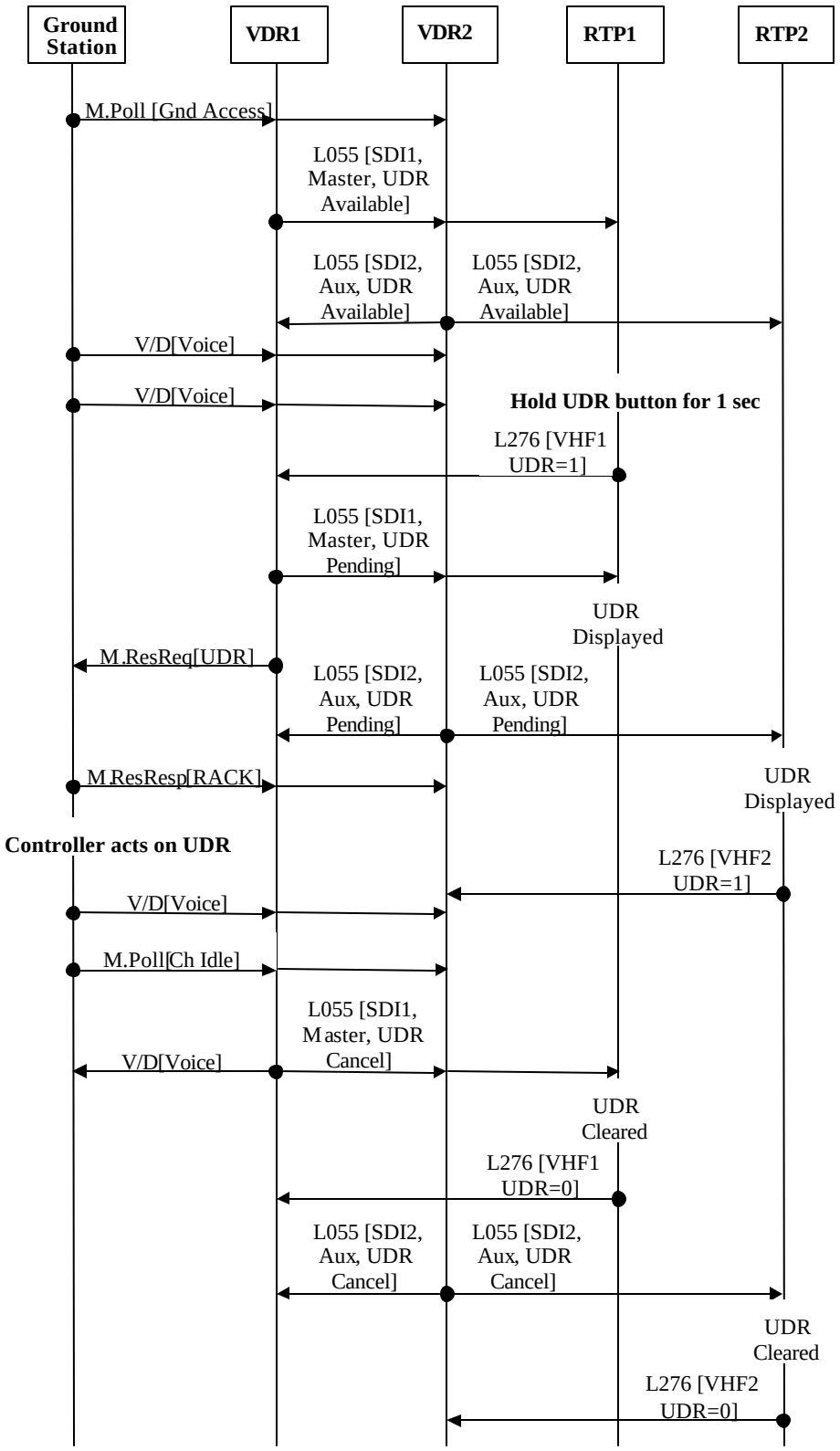


Figure A8-3 Example Sequence of Events for an UDR when Two VDRs Are Tuned to the Same Channel

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

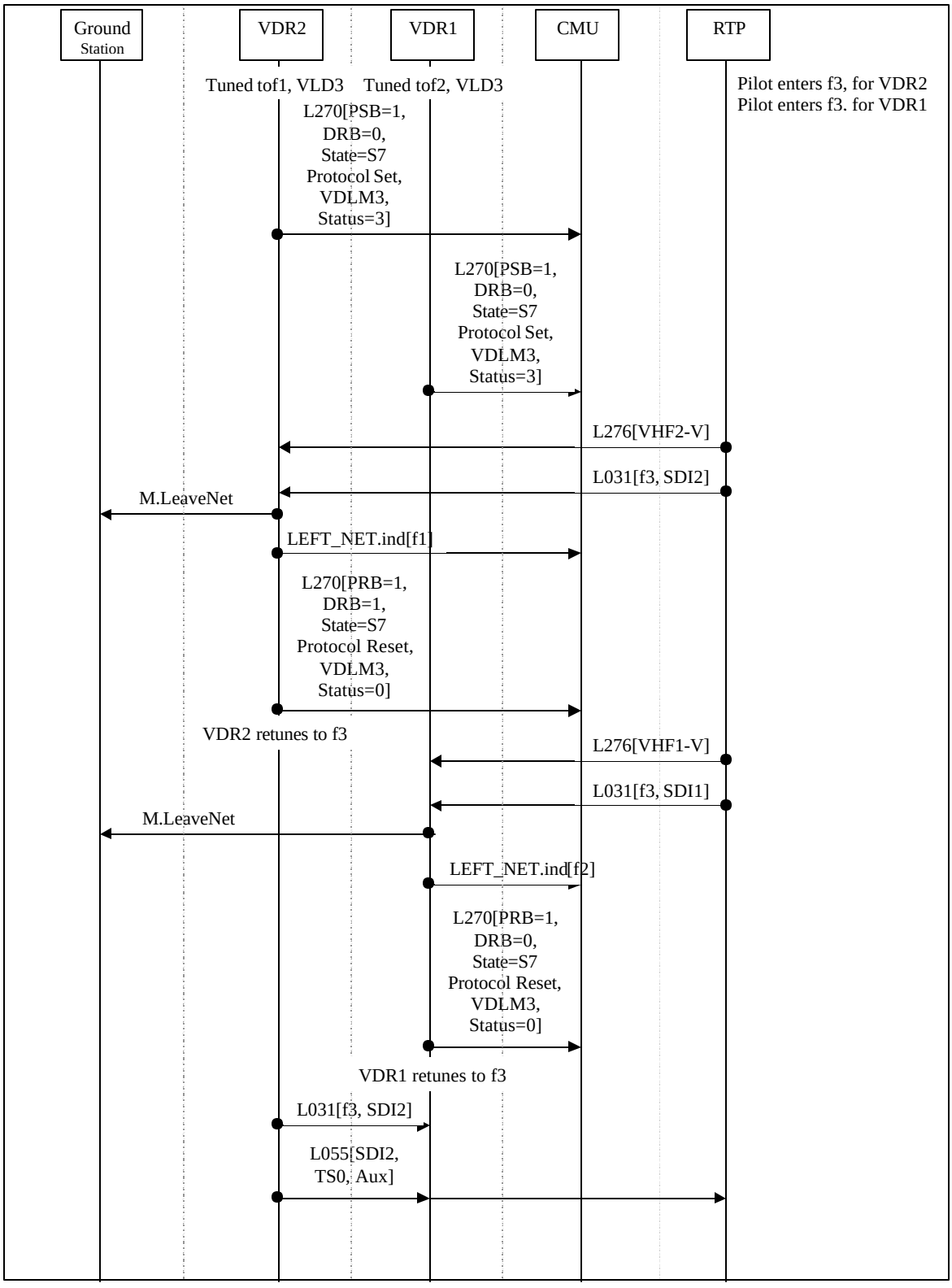


Figure A8-4a Example Sequence of Events for Radio Coordination with Two VDRs Are Tuned to the Same Channel (1 of 4 pages)

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

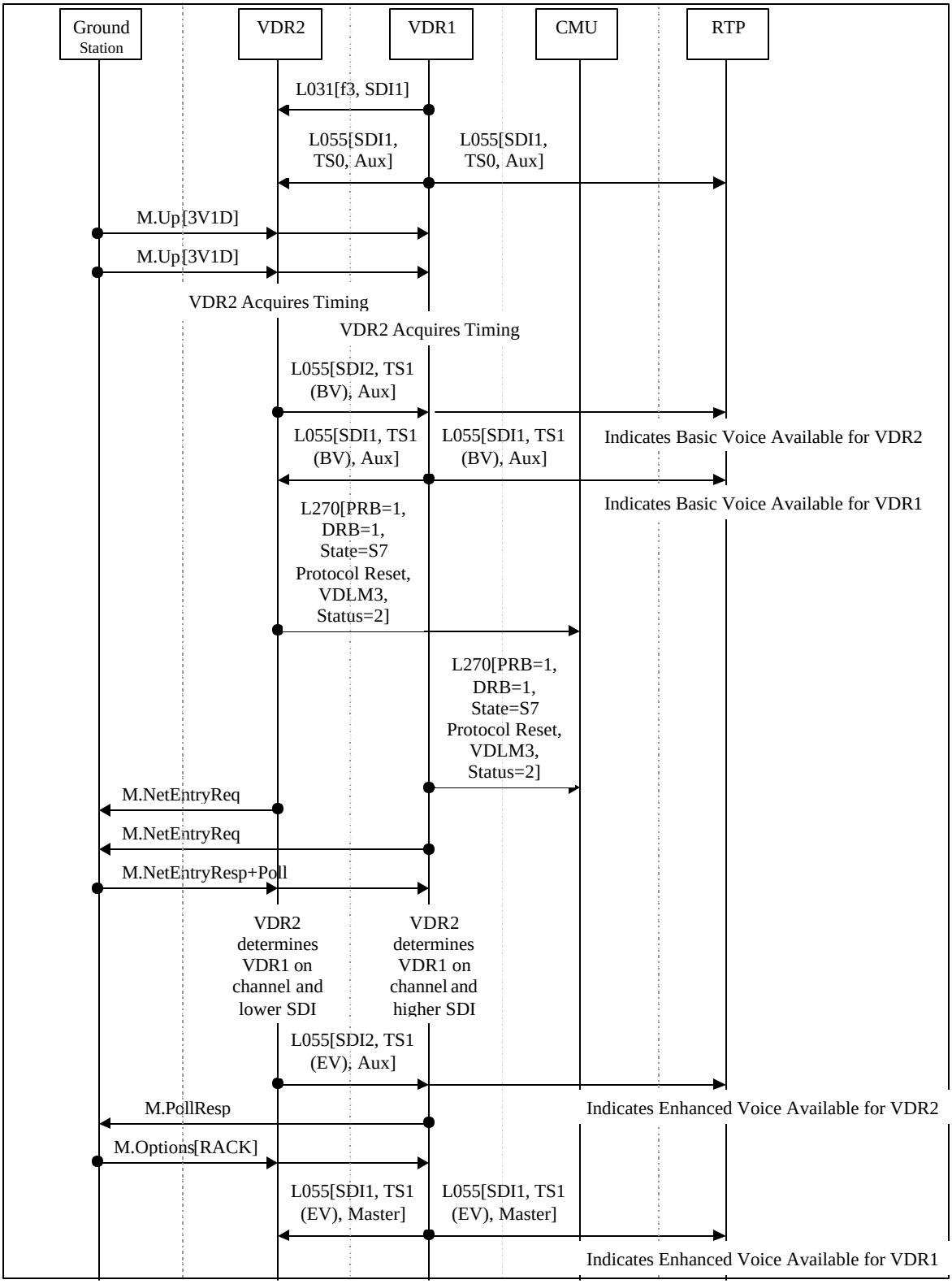


Figure A8-4b Example Sequence of Events for Radio Coordination with Two VDRs Are Tuned to the Same Channel (2 of 4 pages)

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

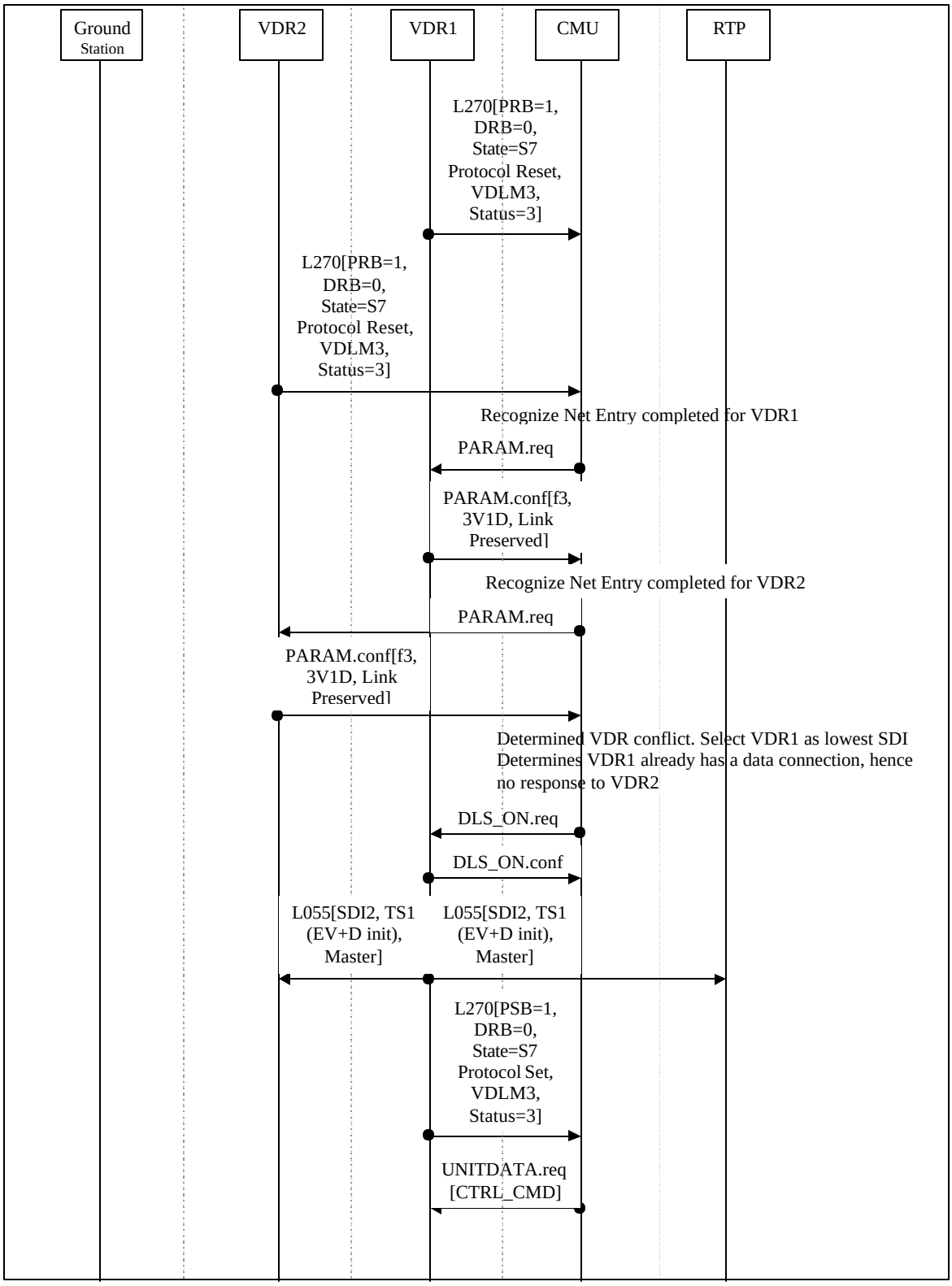


Figure A8-4c Example Sequence of Events for Radio Coordination with Two VDRs Are Tuned to the Same Channel (3 of 4 pages)

ATTACHMENT 8 (cont'd)
VDR TABLES AND FIGURES

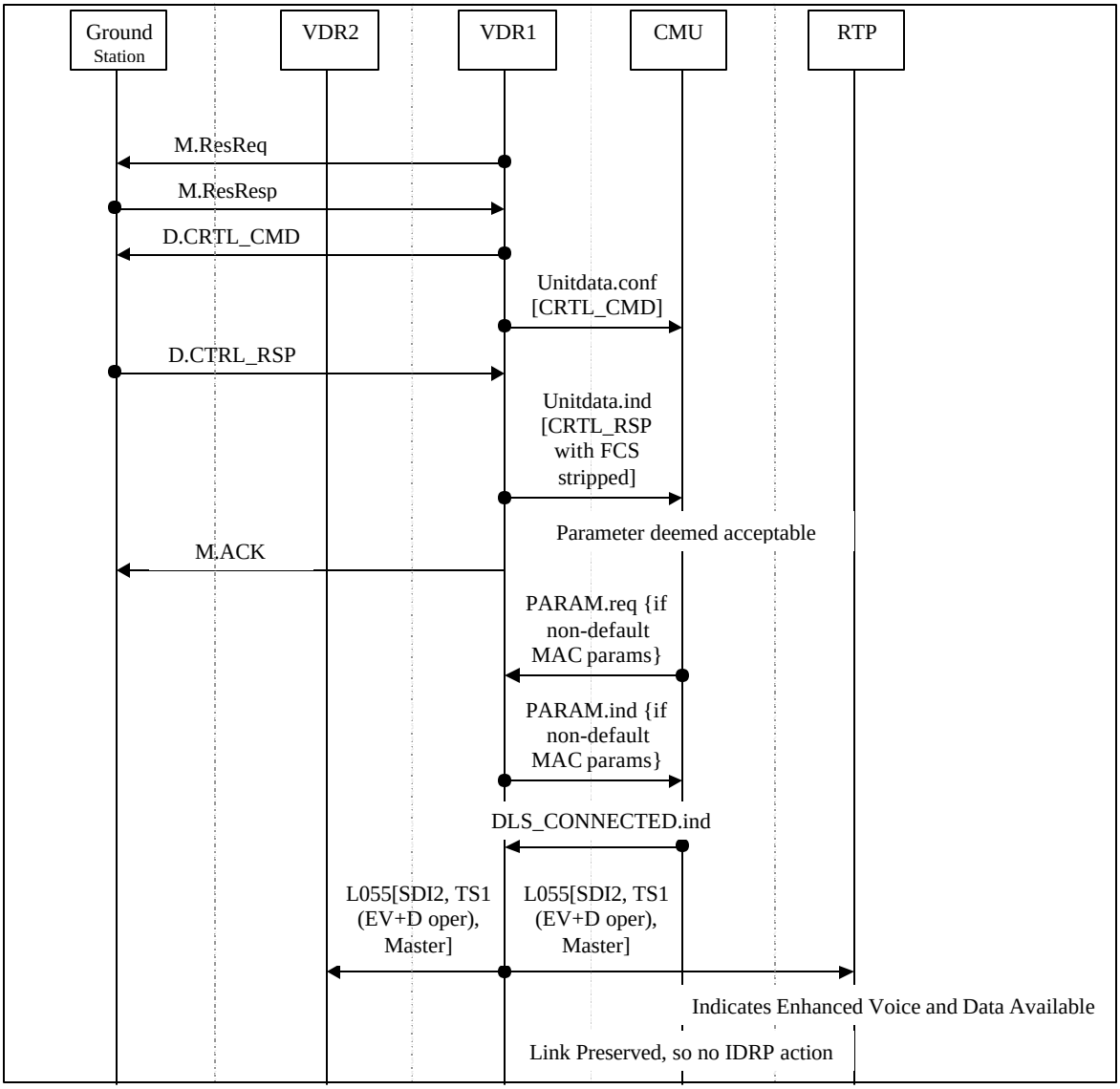
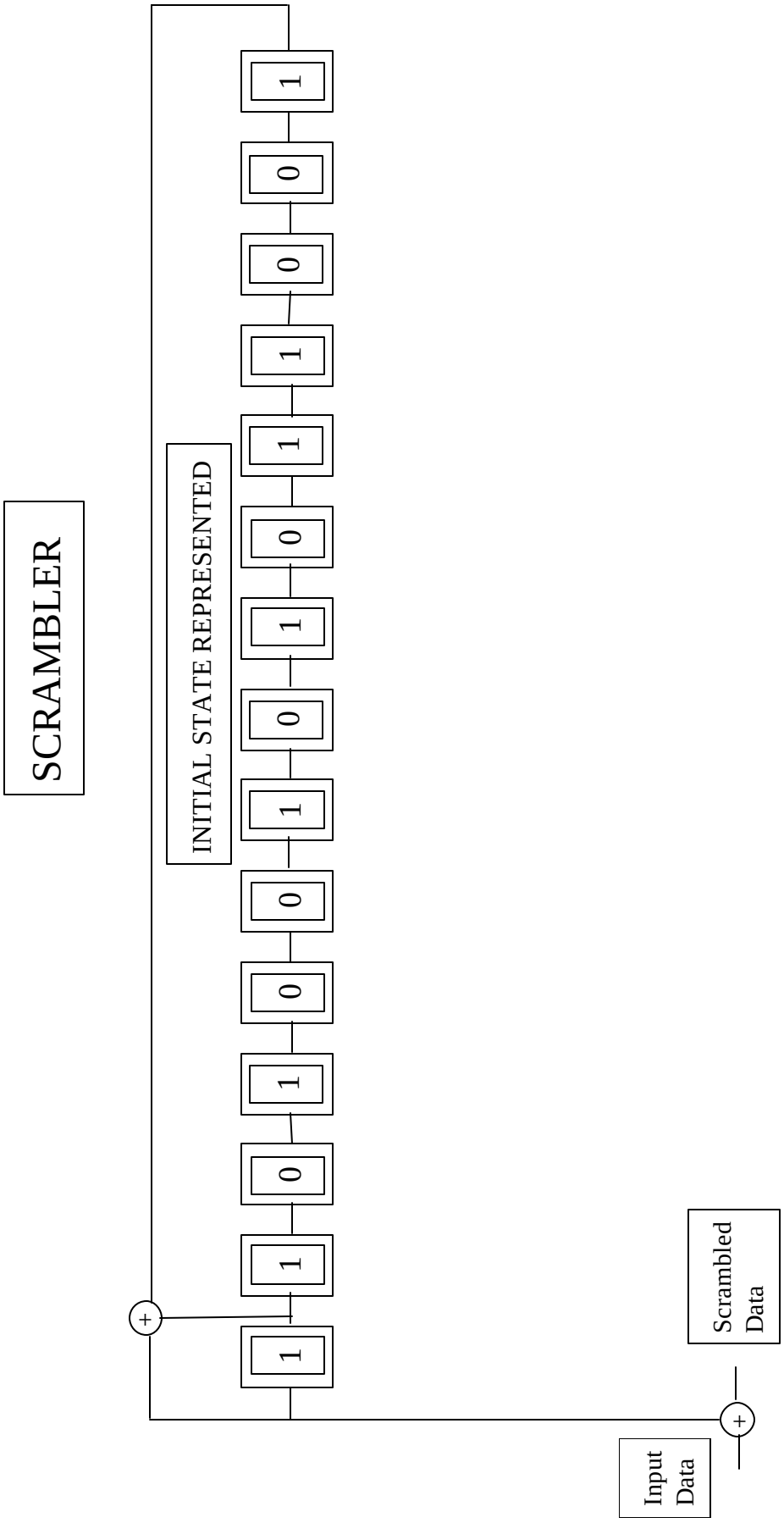


Figure A8-4d Example Sequence of Events for Radio Coordination with Two VDRs Are Tuned to the Same Channel (4 of 4 pages)

ATTACHMENT 9
SCRAMBLER FUNCTIONAL BLOCK



ATTACHMENT 10
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

A10.1 Purpose

This attachment to ARINC Characteristic 750 defines the Aviation VHF Link Control (AVLC) Simple Interface Protocol (ASIP). The ASIP is a collection of messages, methods and procedures that may be implemented in both a VHF Digital Radio (VDR) and a Communications Management Unit or Management Unit (CMU) to enable the pair to function as an entity in a VDL Mode 2 network.

A10.2 Overview

The defining document that describes the functions, methods and procedures to be implemented by an airborne entity performing VHF Digital Link (VDL) operations is the Standards and Recommended Practices (SARPs) developed by the Aeronautical Mobile Communications Panel (AMCP), "Aeronautical Telecommunications, Annex 10, Volume III – Communications." The protocols and procedures defined in this attachment are an implementation of Section 6.5 of the SARPs, "LINK LAYER PROTOCOLS AND SERVICES", which pertains to packet mode operations.

The CMU and the VDR operate together to implement the functionality defined by Section 6.5 of the SARPs. A functional partitioning can be imposed between the VDR and the CMU to implement the SARPs definition. The ASIP defines a split in link layer functionality between the VDR and the CMU subsystems as well as the protocols and procedures necessary to support it.

The VDL link layer can be considered to be divided into three sublayers:

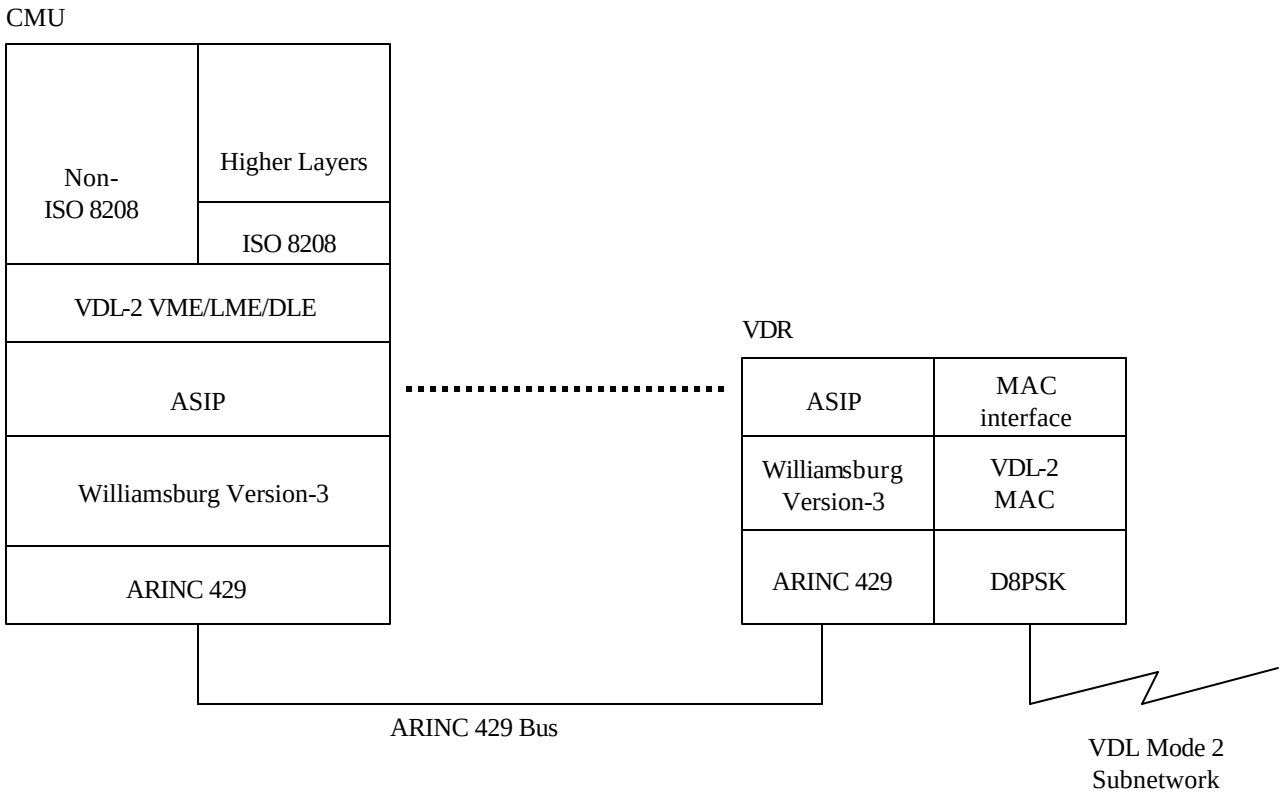
a. A Media Access Control (MAC) sublayer, which uses the Carrier Sense Multiple Access (CSMA) algorithm. This sublayer resides in the VDR.

b. A Data Link Service (DLS) sublayer, which acts as a connection-oriented point-to-point or a connectionless broadcast link over the MAC sublayer. This sublayer resides in both the CMU and VDR.

c. A Link Management Entity (LME) sublayer, which establishes and maintains connections between airborne and ground stations. This sublayer resides in the CMU.

The functional partitioning defined by the ASIP is partially shown in the following diagram. This implementation places the multiple link support solely in the CMU as opposed to splitting the support between VDR and CMU. ARINC Specification 631 contains a function allocation table that indicates whether the function is in the CMU or the VDR.

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)



Note: VDL Mode 2 AVLC protocol includes VME, LME, DLE, and MAC.

Figure A10-1 ASIP Functional Split

A10.3 ASIP Protocols and Procedures

A10.3.1 Overview

The ASIP CMU/VDR Interface Protocol comprises Extended BOP files and Extended SOLO words as defined in Section 5.1.3.1 and 5.1.3.2, respectively. As defined in Section 5.1.2.3, file primitives are of types COMMAND or DATA.

A received RF transmission may contain multiple frames. For each frame in the transmission, the VDR removes both flags and bit stuffing information as well as calculates the FCS. If the FCS is good and the frame meets the address screening requirements of Section A10.4.13, then the VDR sends the frame to the CMU using a single primitive. The frame is stripped of any flags, bit stuffing information, and the FCS.

One of the address-screening criterion is that the frame's destination address should match one of three addresses *except for the A/G Bit*. Each address will conform to the Destination Address Field of the Generic Frame Format shown in Table A10-3. This set of addresses, referred to herein as the Destination Address Set (DAS), is loaded by the CMU using a command primitive. The VDR, prior to its initialization procedure, should contain a null DAS. Consequently, no frames should be passed from the VDR to the CMU until the DAS contains a valid destination address.

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

The VDR sends a Signal Quality Parameter (SQP) indication message (SQP.indication) to the CMU for every received transmission from the ground that contains a valid FCS. The SQP indication is used by the LME function, which resides in the CMU. The SQP reporting function is disabled prior to the VDR's initialization and is enabled when the CMU sends operational parameter data to the VDR. The SQP message contains the address of the transmitting station and a parameters corresponding to the signal quality of that transmission.

The VDR periodically sends a Channel Utilization (CU) indication message (CU.indication) to the CMU. This message contains a parameter that indicates the percentage of time that the channel is occupied either by the VDR or by other stations.

A frame to be sent by the CMU is passed to the VDR devoid of any flag, bit stuffing, or FCS information. The VDR adds this information to the frame prior to transmission. In addition to the frame data, the message from the CMU will contain the sequence number for that frame. After the frame has been removed from the VDR's transmit buffer, the VDR will send a confirmation message to the CMU. This confirmation message will contain an indication of whether the frame was transmitted, the sequence number and the MAC delay for that frame.

The VDR maintains a timer (TM2 timer) whose expiration will indicate that the channel is occupied. When the TM2 timer expires the VDR will send a Channel Congested indication message (CHAN_CONG.indication) to the CMU. Upon expiration of the TM2 timer, the VDR will purge any untransmitted frames.

If the VDR *receives a PARAM.request message*, then it will delete all untransmitted frames and send a confirmation message to the CMU for each deleted frame.

The CMU is provided a primitive with which it may command the VDR to purge all untransmitted frames. For each purged frame, the VDR will send a confirmation message to the CMU.

A10.3.2 ARINC 429 Interface Definition

The ASIP should be implemented using only the ARINC 429 Williamsburg Version 3 bit oriented protocol. Williamsburg Version 3 Command Frames should be used for all file transfers.

A10.3.3 BOP File Transfer GFI Code

The GFI code (contained in the FDU's Start of File (SOF) word) associated with all BOP data files should be set to "F_h", indicating an extended GFI.

A10.3.4 BOP File Transfer Command Type Code

The Command Type Code (contained in bits 23 - 24) of the Command Frame SOF word, should be set according to the following values:

Command primitives	0_h
Data transfer primitives	1_h

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

Only the UNITDATA.request and UNITDATA.indication primitives are currently defined to have a Command type code of 1_h. All remaining primitives are command primitives and as such have a Command type code of 0_h.

A10.3.5 General File Format

The format of all BOP file transfers conforms to a common format for data transfer and is shown in ARINC Characteristic 750, Section 5.1.3.1, BOP File Transfer Extended GFI Code.

A10.3.6 ASIP Extended SOLO Word Format

The general Extended SOLO word definition in Section 5.1.3.2 leaves bits 9 through 20 undefined. These bits were left as an unspecified data field to be defined in a specific CMU/VDR Interface Protocol.

The ASIP format for Extended SOLO words is as follows:

Bit	***Definition***	***Comment***
32	***Parity***	
31-29	***"101_b"***	***(indicates SOLO)***
28-25	***"F_h"***	***(indicates Extended SOLO Word)***
24-21	***"1_h"***	***(indicates ASIP CMU/VDR Interface Protocol)***
20-18	***PID***	***Primitive ID, one of eight***
17-09	***Data***	***9-bit data field***
08-01	***SAL***	

A10.4 Procedures

A10.4.1 Initialization

Section 5 defines the CMU-to-VDR interface as providing support for multiple interface protocols. It defines the initialization procedure to be performed in order to bring the interface to a functional state upon reset or power up. As part of initialization, the VDR determines the status of any CMU on the ARINC 429 bus and negotiates the Williamsburg version to be used. As defined in the procedures of Section 3.3 and per Table ***3-2***, the VDR determines the correct operating mode. The procedures in Section 5.2 define ***the CMU/VDR*** initialization.

A10.4.2 VDR Periodic Reporting

The VDR periodically sends broadcast words to the CMU to convey status information as defined in Section 5.5.

A10.4.3 CMU Periodic Reporting

The CMU periodically sends broadcast words to the VDR to convey status information as defined in Section 5.5.

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

A10.4.4 VDR Error Message

If the VDR experiences a protocol error during its operation with the CMU, it should send a VDR_ERROR.indication message. This message may be used to indicate that the VDR has received a message out of sequence, that the message is unrecognized, or that the message format is in error.

A10.4.5 CMU Error Message

If the CMU experiences a protocol error during its operation with the VDR, it should send a CMU_ERROR.indication message. This message may be used to indicate that the *CMU* has received a message out of sequence, that the message is unrecognized, or that the message format is in error.

A10.4.6 VDR Operating Parameter Data

If the VDR receives a PARAM.request message from the active CMU, it transmits a PARAM.confirm to the CMU within 1 second of the reception. The PARAM.request message is used to set all operating parameters for the VDR, including operating frequency, mode, persistence, M1, TM1, and TM2. The VDR, upon *sending a PARAM.confirm message*, transitions to the PROTOCOL_SET protocol substate.

COMMENTARY

> The only primitive available to the CMU to query the VDR for a list of its operational parameters is the PARAM.request primitive. As the VDR responds with a PARAM.confirm to every instance of a PARAM.request, the content of the PARAM.confirm message can be used by the CMU to indicate error conditions or unsupported parameters in the VDR.

In the event that the VDR cannot set the operating parameters to the values requested by the CMU in a PARAM.request message, it should not declare an error event. Instead, the VDR should continue to function normally using the values it reported in the PARAM.confirm message it sent to the CMU. The CMU should make a determination if the mismatch in the contents of the PARAM.request and the PARAM.confirm messages is sufficient to warrant either a VDR reset or a failure declaration.

A10.4.7 Signal Quality Parameter Reporting

The VDR should send an SQP.indication message to the CMU for every transmission it receives from a ground station. This message should be sent within 1 second of receipt; however, it should only be sent if the frame in that transmission is received with a valid FCS. SQP reporting is enabled only while the VDR is in the PROTOCOL_SET substate.

The SQP value should be determined from the RF signal strength using the following formula:

if (PdBm $\leq$ -98), then SQP = 0.

if (-98 < PdBm < -27), then SQP = INT(((100+PdBm)/5) + 0.5)

if (P $\geq$ -27) then SQP = 15

The signal strength measurement should be accurate to ± 7 dB and be monotonic.

The SQP.indication message will contain the SQP value, the four octets that consist of the Source Address Field of the Generic Frame Format (Table A10-3), and the VHF frequency in use at the time that the uplink was received.

A10.4.8 Address Request

In order to receive any incoming frames, the CMU should send an ADDR.request message to the VDR containing up to three addresses setting the contents of the DAS. An address will consist of the four octets designated as the Destination Address Field of the Generic Frame Format in Table A10-3.

The ADDR.request message is sent by the CMU to the VDR to set the content of the DAS or to request a report contain the content of the DAS.

The VDR's DAS should be able to contain three addresses. As any address sent via this message will replace the DAS's content in its entirety, the CMU can set the DAS to NULL by sending a NULL address list with the control octet value of 01_h (set).

The CMU can request a copy of the existing DAS by sending an ADDR.request message with a control octet value of 00_h. The DAS's content in the VDR is not modified by an ADDR.request message with a control octet value of 00_h. The VDR responds with an ADDR.confirm message containing *all of* the currently loaded addresses.

The three addresses loaded by the CMU into the VDR will typically be set such that a frame will be sent to the CMU if its Destination Address Field matches one of the following:

a. the aircraft's ICAO assigned 24-bit address with an associated 3-bit type field indicating "Aircraft",
c. the "all ones" address with an associated 3-bit type field indicating "All stations broadcast".

Address type field encoding is shown in Table A10-4.

A10.4.9 Address Response

The VDR should send the CMU an ADDR.confirm message containing a list of all currently loaded addresses. The VDR sends this message in response to any ADDR.request message from the CMU.

A10.4.10 Channel Utilization Parameter

The VDR should send the CMU an indication of the percentage of the time that the channel is busy. The CU parameter should be sent to the CMU in a CU.indication message at 1-second intervals.

CU is calculated in the VDR by determining the percentage of time that the channel is occupied during a 1 second reporting interval. The VDR should sample the channel at 1 millisecond intervals or more often. CU can range in value from 0 to 100, with 100 corresponding to a channel that is 100 percent occupied. The channel is considered occupied if either the VDR is transmitting or D8PSK signal is detected at the time the sample is taken.

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

COMMENTARY

CU is used by the frame layer for calculating frame lifetimes. An algorithm for calculating CU has not been simulated or tested as of this version. As such, it is not known at this time what the effects of the dynamics of a time-varying CU have on the network performance. It is hoped that by having the VDR frequently report the CU data that any future changes can be accommodated within the CMU and not require a VDR modification.

A10.4.11 Downlink Message Handling

To send a message to the ground, the CMU will send the VDR a UNITDATA.request message. The content of the data portion of this message is dependent on the type of frame to be sent, (INFO, RR, SREJ, etc.), and will contain all information necessary to compose one frame consistent with its type except the flag, bit stuffing, and FCS information. Prior to each frame's transmission, the VDR will calculate the FCS, append the FCS information, and perform both bit stuffing and flag delineation.

Under normal circumstances, the maximum time from receipt of the UNITDATA.request to the start of the frame's RF transmission will vary depending on channel occupancy and p-persistence value; nevertheless, for the special condition of a clear channel and P = 1, the VDR should start the frame's transmission within Tdown milliseconds.

*Tdown = 65 +35*ceil (message_length_in_bytes/255) ms, where ceil(x) rounds to the nearest integer greater than or equal to x, and where message_length_in_bytes is measured after the message header.*

Tdown is measured from the end of the last bit of the UNITDATA.request ARINC 429 transmission to the start of the downlink transmission.

The UNITDATA.request message also contains a sequence number used to explicitly correlate UNITDATA.request messages and UNITDATA.confirm messages. It is the responsibility of the CMU to correctly assign sequence numbers. The CMU should manage the sequence number assignment to ensure that each frame in the VDR transmit buffer has a unique value. It is recommended (but not required) that the sequence number assignment monotonically increase without gaps then wrap around to 1.

COMMENTARY

The VDR may check the sequence numbers for uniqueness and report duplicates using the VDR_ERROR.indication primitive.

A10.4.12 Uplink Message Handling

If a valid received frame meets the address screening requirements of Section A10.4.13, then the VDR should send the CMU a UNITDATA.indication message within Tup milliseconds.

Tup = 65 + 35 ceil (message_length_in_bytes/255) ms, where ceil(x) rounds to the nearest integer greater than or equal to x, and where message_length_in_bytes is measured after the message header. The Tup time applies only to an RF message that contains one frame. Tup is measured from the end of*

the last symbol of the received RF message at the receiver input, to the start of the first bit of the UNITDATA.indication transmission to the CMU.

The content of the data portion of this message is dependent on the type of frame received (INFO, RR, SREJ, etc.). The UNITDATA.indication message should contain all the information necessary to compose the frame consistent with its type except the flag, bit stuffing, and FCS information, as the VDR strips these from the frame prior to sending the UNITDATA.indication to the CMU.

A10.4.13 Address Screening

A received frame should contain source and destination address fields. Before a received frame can be sent to the CMU, its destination address field should match one of the three addresses stored in the DAS *except the A/G bit*."

Table A10-3 shows a generic frame format. Table A10-4 shows the Address Type Field encoding.

A10.4.14 Error Handling and Recovery

The CMU, through examination of the PARAM.confirm message or by other indications, may determine that the VDR is in an unknown state. ***The CMU can return the CMU/VDR Interface to a known state by sending the VDR either a MODE_SET.request or PR_SET.request message as described in Section 5.2.***

The MODE_SET.request and PR_SET.request messages are sent using the command and control mechanism defined in Section 5.

Either the VDR or the CMU can send a VDR_ERROR.indication or CMU_ERROR.indication message, respectively as the result of various protocol specific error conditions that may occur. The content of the error message provides an error code as well as an octet for an error data field. If the error occurred as the result of processing a received primitive, (due to bad data length, for example) the error data field should contain the PID of the offending primitive (as currently defined).

A10.4.15 VDR Buffer Management and Flow Control

For each air-to-ground virtual connection the number of un-acknowledged transmitted frames is limited to the window size for that link. If the CMU were to send this number of frames to the VDR for transmission and if the RF channel were busy, the VDR would have to buffer these frames until they could be transmitted. If the CMU had more than one air-to-ground virtual connection active and if the channel were busy, then the VDR would have to buffer a window size number of frames for each virtual connection. It is recognized that a VDR implementation may not provide sufficient buffer capability to accommodate this number of untransmitted frames.

To manage this possibility the VDR is provided the flow control primitives, XON.request/ XOFF.request defined in section 5.3.3 herein, with which it may request flow control of FDUs sent by the CMU. The VDR will send an XOFF.request message to the CMU to request that the CMU send no FDUs of the type specified in the Type Field of the XOFF.request message.

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

Due to the possibility of delay in the reception and subsequent processing of the XOFF.request message by the CMU, after the VDR has sent an XOFF.request message to the CMU, the VDR should be able to receive and process at least one additional FDU of the type specified in the Type Field in the XOFF.request message.

If the VDR cannot process an FDU received from the CMU, then the VDR should send the CMU a VDR_ERROR.indication with the error code set to buffer overflow. See Table A10.2.

COMMENTARY

No specific flow control mechanism is defined for transfers from VDR to CMU. It is assumed that the CMU provides sufficient capabilities to absorb the uplink traffic. It should be noted that a ground station may send several frames to the same aircraft within one uplink transmission. The VDR will have to wait for complete reception of the uplink string of bits in order to properly decode it. The multiple associated Unitadata indication and SQP indication FDUs will thus have to be sent in burst to the CMU, as described in Figure A10-11. The VDR should provide sufficient buffering capabilities to properly transfer these frames to the CMU while receiving a new uplink from the ground. Implementors should note that ARINC Specification 631 allows up to 7 frames to be transmitted per VDL link within one single CSMA access to the same aircraft.

A10.4.16 VDR Transmit Buffer Purging

If the VDR's transmit buffer contains untransmitted frames and the VDR receives a PURGE.request or PARAM.request message, then the VDR will clear the transmit buffer of all untransmitted frames. For each untransmitted frame the VDR will send a UNITDATA.confirm whose Transmit Status field will be set to 01_h indicating that the frame was discarded (Section A10.5.12).

A10.4.17 Vendor Reserved Primitives

A set of sixteen primitives are reserved and may be assigned by a manufacturer for purposes outside the scope of this definition. ***Some of the primitives have been set aside per vendor requests for specific functions unique to those vendors. These reserved primitive ID values should only be used by the vendor that they are assigned to, see section A10.5.15.*** These purposes may include, but are not limited to debugging and special test modes. These Extended BOP file primitives of undefined type (COMMAND or DATA), include the ID codes $F0_h$ through FF_h.

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

A10.5 Primitives

The following primitives are defined:

Parameter Name	Subsection
UNITDATA.request	A10.5.2
UNITDATA.indication	A10.5.7
UNITDATA.confirm	A10.5.12
PARAM.request	A10.5.1
PARAM.confirm	A10.5.6
VDR_ERROR.indication	A10.5.9
CMU_ERROR.indication	A10.5.4
CU.indication	A10.5.11
SQP.indication	A10.5.10
ADDR.request	A10.5.3
ADDR.confirm	A10.5.8
CHAN_CONG.indication	A10.5.13
PURGE.request	A10.5.14

The primitives that are transferred between VDR and CMU are used for all command and data transfer. Primitives are of three generic types:

REQUEST The REQUEST primitive is passed between the VDR and CMU when a response may be required. Primitives of this type have the form XXX.request.

CONFIRM The CONFIRM primitive is passed between the VDR and CMU in response to a previous REQUEST primitive. Primitives of this type have the form XXX.confirm.

INDICATION The INDICATION primitive is passed between the VDR and the CMU to convey unsolicited information such as user data or error messages. Primitives of this type have the form XXX.indication.

The general format of all messages exchanged using the Extended BOP file transfer between the CMU and VDR is as defined in Section 5.1.3.1. For primitives composed of Extended SOLO words, the format is as defined in Section 5.1.3.2.

A10.5.1 Message PARAM.request

The CMU sends the PARAM.request message to set all operating parameters, except addresses, for the VDR, including operating frequency and modulation mode.

Message Format

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet	Parameters	Value or Range
1	EGFI	F1h
2	Primitive ID	20h
3	Data field length MSB	00h
4	Data field length LSB	07h
5	Frequency MSB	(tens, ones of freq. in MHz) 18 to 36 (12h to 24h) for 118 through 136 MHz.
6	Frequency LSB	(tenths, hundredths of freq. in MHz, ignore 1000ths) 00 to 97 (00h to 61h) for xxx.000 through xxx.975 MHz. Example: freq = 121.775 MSB = 21 = 15h LSB = 77 = 4Dh (ignore thousandths place)
7	TM1 value	0.5 to 125 ms (01h to FAh), 0.5 ms step size.
8	TM2 value	6 to 120 sec (06h to 78h), 1 sec stepsize.
9	M1 MSB	00h to FFh. Valid value for M1 is 1 through 65535.
10	M1 LSB	00h to FFh
11	p-Persistence value	1/256 to 1 (00h to FFh), 1/256 step size.

Normal response

The VDR responds to this message with a PARAM.confirm message containing the VDR's active values for all the above parameters. *If as a result of this command, the VDR purges frames from its transmit buffer, then the VDR sends a UNITDATA.confirm message for each frame as a response to an outstanding unacknowledged UNITDATA.request command previously received from the CMU.*

Error response

In the event that the VDR detects an error in the data contained in the message, it sends a VDR_ERROR.indication message. An unsupported parameter value is not an error and should trigger a PARAM.confirm message, not a VDR_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_RESET and PROTOCOL_SET substates of state ***CMD***.

New State

The resulting state is unchanged.

A10.5.2 Message UNITDATA.request

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

The CMU sends the UNITDATA.request message to send AVLC data to the VDR. This message contains one frame to be transmitted by the VDR in the next available transmission.

Message Format

The message consists of one Extended BOP file of type DATA containing the following:

Octet	Parameters	Value or Range
1	EGFI	F1h
2	Primitive ID	21h
3	Data field length MSB	MSB (0 to FFh)
4	Data field length LSB	LSB (0 to FFh)
5	Sequence number	0 to FFh (0 to 255)
6	Data field byte #1	All bytes of data to be sent are consecutively ordered.
7	Data field byte #2	
.	.	
.	.	
.	.	
N+5	Data field byte #N	

Normal response

UNITDATA.confirm containing sequence number when the frame is transmitted or deleted.

Error response

In the event that the VDR detects an error in the data contained in the message, it sends a VDR_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_SET substate of state ***CMD***.

New State

The resulting state is unchanged.

A.10.5.3 Message ADDR.request

The CMU sends the ADDR.request message to manage the addresses used by the VDR for address screening. Depending on the contents, the CMU can either request a report of the addresses or set the addresses in the DAS. Any addresses set using this primitive should completely replace the existing contents

of the DAS. Thus, if the CMU wishes to delete the content of the DAS, it can do so by sending a NULL table to the VDR (*octets 6 to 17* = 0) with the control octet set to a value of 01_h. If the CMU wishes to request a copy of the DAS, it can do so by sending a NULL table to the VDR (*octets 6 to 17* = 0) with the control octet set to a value of 00_h.

The four octets of each address contained in the ADDR.request message directly correspond to the four octets that make up the Destination Address Field *except for the A/G bit* of the Generic Frame Format shown in Table A10.3. An example of an ADDR.request message that follows this convention is shown following Table A10-3.

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet	Parameters	Value or Range
1	EGFI	F1h
2	Primitive ID	22h
3	Data field length MSB	00h
4	Data field length LSB	0Dh accounts for control octet, three addresses.
5	Control octet	00h = request list of all addresses in DAS. 01h = set the following addresses.
6	Address 1, octet 1	Bit 8 corresponds to bit 22 of the Station Address.
7	Address 1, octet 2	Bit 8 corresponds to bit 15 of the Station Address.
8	Address 1, octet 3	Bit 8 corresponds to bit 8 of the Station Address.
9	Address 1, octet 4	Bit 8 corresponds to bit 1 of the Station Address.
10	Address 2, octet 1	Bit 8 corresponds to bit 22 of the Station Address.
11	Address 2, octet 2	Bit 8 corresponds to bit 15 of the Station Address.
12	Address 2, octet 3	Bit 8 corresponds to bit 8 of the Station Address.
13	Address 2, octet 4	Bit 8 corresponds to bit 1 of the Station Address.
14	Address 3, octet 1	Bit 8 corresponds to bit 22 of the Station Address.
15	Address 3, octet 2	Bit 8 corresponds to bit 15 of the Station Address.
16	Address 3, octet 3	Bit 8 corresponds to bit 8 of the Station Address.
17	Address 3, octet 4	Bit 8 corresponds to bit 1 of the Station Address.

Normal response

The VDR should respond with a ADDR.confirm message.

Error response

In the event that the VDR detects an error in the data contained in the message, it sends a VDR_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

State

This message is processed in the PROTOCOL_RESET and PROTOCOL_SET substates of state ***CMD***.

New State

The resulting state is unchanged.

A10.5.4 Message CMU_ERROR.indication

The CMU sends the CMU_ERROR.indication message to indicate that a protocol error occurred. Protocol errors can include the reception of a message out of sequence for the current state, an unrecognized primitive, or a format error in the message.

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet	Parameters	Value or Range
1	EGFI	F1h
2	Primitive ID	23h
3	Data field length MSB	0
4	Data field length LSB	2
5	Error code	See Table A10-2
6	Error data	See Table A10-2

Normal response

None.

Error response

In the event that the VDR detects an error in the data contained in the message, it sends a VDR_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_RESET and PROTOCOL_SET substates of state ***CMD***.

New State

The resulting state is unchanged.

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

A10.5.5 Reserved

A10.5.6 Message PARAM.confirm

The VDR sends the PARAM.confirm message in response to a PARAM.request message. It contains the VDR's current operational parameters.

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet	Parameters	Value or Range
1	EGFI	F1h
2	Primitive ID	50h
3	Data field length MSB	00h
4	Data field length LSB	07h
5	Frequency MSB	(tens, ones of freq. in MHz) 18 to 36 (12h to 24h) for 118 through 136 MHz.
6	Frequency LSB	(tenths, hundredths of freq. in MHz, ignore 1000ths) 00 to 97 (00h to 61h) for xxx.000 through xxx.975 MHz. Example: freq = 121.775 MSB = 21 = 15h LSB = 77 = 4Dh (ignore thousandths place)
7	TM1 value	0.5 to 125 ms (01h to FAh), 0.5 ms step size
8	TM2 value	6 to 120sec (06h to 78h), 1 sec step size.
9	M1 MSB	00h to FFh. Valid value for M1 is 1 through 65535.
10	M1 LSB	00h to FFh
11	p-Persistence value	1/256 to 1 (00h to FFh), 1/256 step size.

Normal response

None.

Error response

In the event that the CMU detects an error in the data contained in the message, it sends a CMU_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_RESET and PROTOCOL_SET substates of state ***CMD***.

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

New State

The resulting state is the PROTOCOL_SET substate of ***CMD***.

A10.5.7 Message UNITDATA.indication

The VDR sends the UNITDATA.indication message to send AVLC data to the CMU.

Note: The UNITDATA.indication and SQP.indication should be sent in the order shown in Figures A10-4 and A10-11.

Message Format

The message consists of one Extended BOP file of type DATA containing the following:

Octet	Parameters	Value or Range
1	EGFI	F1h
2	Primitive ID	51h
3	Data field length MSB	MSB (0 to FFh)
4	Data field length LSB	LSB (0 to FFh)
5	Frequency MSB	(tens, ones of freq. in MHz) 18 to 36 (12h to 24h) for 118 through 136 MHz.
6	Frequency LSB	(tenths, hundredths of freq. in MHz, ignore 1000ths) 00 to 97 (00h to 61h) for xxx.000 through xxx.975 MHz. Example: freq = 121.775 MSB = 21 = 15h LSB = 77 = 4Dh (ignore thousandths place)
7	Data field byte #1	All bytes of data to be sent are consecutively ordered.
8	Data field byte #2	
.		.
.		.
.		.
N+6	Data field byte #N	

Normal response

None.

Error response

In the event that the CMU detects an error in the data contained in the message, it sends a CMU_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

State

This message is processed in the PROTOCOL_SET substate of state ***CMD***.

New State

The resulting state is unchanged.

A10.5.8 Message ADDR.confirm

The VDR sends the ADDR.confirm message in response to an ADDR.request. It contains the content of the DAS.

The four octets of each address contained in the ADDR.confirm message directly correspond to the four octets that make up the Destination Address Field of the Generic Frame Format shown in Table A10.3. An example of an ADDR.request message that follows this convention is shown following Table A10-3.

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet	Parameters	Value or Range
1	EGFI	F1h
2	Primitive ID	52h
3	Data field length MSB	00h
4	Data field length LSB	0Ch
5	Address 1, octet 1	Bit 8 corresponds to bit 22 of the Station Address.
6	Address 1, octet 2	Bit 8 corresponds to bit 15 of the Station Address.
7	Address 1, octet 3	Bit 8 corresponds to bit 8 of the Station Address.
8	Address 1, octet 4	Bit 8 corresponds to bit 1 of the Station Address.
9	Address 2, octet 1	Bit 8 corresponds to bit 22 of the Station Address.
10	Address 2, octet 2	Bit 8 corresponds to bit 15 of the Station Address.
11	Address 2, octet 3	Bit 8 corresponds to bit 8 of the Station Address.
12	Address 2, octet 4	Bit 8 corresponds to bit 1 of the Station Address.
13	Address 3, octet 1	Bit 8 corresponds to bit 22 of the Station Address.
14	Address 3, octet 2	Bit 8 corresponds to bit 15 of the Station Address.
15	Address 3, octet 3	Bit 8 corresponds to bit 8 of the Station Address.
16	Address 3, octet 4	Bit 8 corresponds to bit 1 of the Station Address.

Normal response

None.

Error response

In the event that the CMU detects an error in the data contained in the message it sends a VDR_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_RESET and PROTOCOL_SET substates of state ***CMD***.

New State

The resulting state is unchanged.

A10.5.9 Message VDR_ERROR.indication

The VDR sends the VDR_ERROR.indication message to indicate that a protocol error occurred. Protocol errors can include the reception of a message out of sequence for the current state, an unrecognized primitive, or a format error in the message or VDR transmit buffer overflows (CMU sends frame when buffer is full).

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet	Parameters	Value or Range
1	EGFI	F1h
2	Primitive ID	53h
3	Data field length MSB	00h
4	Data field length LSB	02h
5	Error code	See Table A10-2.
6	Error data	See Table A10-2.

Normal response

None.

Error response

In the event that the CMU detects an error in the data contained in the message, it sends a CMU_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_RESET and PROTOCOL_SET substates of state ***CMD***.

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

New State

The resulting state is unchanged.

A10.5.10 Message SQP.indication

The VDR sends the SQP.indication, a "quality of service" report message, once per any transmission received from the ground containing a frame whose FCS is good. A ground station transmitted message is indicated by the content of the type field of the source address. The type field in the source address comprises bits 25 through 27 of the Station Address field (as shown in Table A10-3) and should be encoded as indicated in Table A10-4 for the entries in the comment field: "ICAO-administered" and "ICAO-delegated." The SQP.indication message should only be sent while the VDR is in the PROTOCOL_SET state.

The SQP.indication message contains data that indicates the "quality of service" parameter, the source address of the originating ground station, and the frequency in use when the uplink was received. This information is used by the LME for station hand-off and link control procedures.

The four octets of the address contained in the SQP.confirm message directly correspond to the four octets that make up the Source Address Field of a frame in the received transmission as shown in the Generic Frame Format shown in Table A10-3.

Note: The UNITDATA.indication and SQP.indication should be sent in the order shown in Figures A10-4 and A10-11.

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet	Parameters	Value or Range
1	EGFI	F1h
2	Primitive ID	54h
3	Data field length MSB	00h
4	Data field length LSB	07h
5	SQP	00h to 0Fh (0 to 15), quality of service indicator, 0 = poorest quality, 15 = best quality (See A10.4.7)
6	Source address, octet 1	Bit 8 corresponds to bit 22 of the Station Address.
7	Source address, octet 2	Bit 8 corresponds to bit 15 of the Station Address.
8	Source address, octet 3	Bit 8 corresponds to bit 8 of the Station Address.
9	Source address, octet 4	Bit 8 corresponds to bit 1 of the Station Address.
10	Frequency MSB	(tens, ones of freq. in MHz) 18 to 36 (12h to 24h) for 118 through 136 MHz.
11	Frequency LSB	(tenths, hundredths of freq. in MHz, ignore 1000ths) 00 to 97 (00h to 61h) for xxx.000 through xxx.975 MHz. Example: freq = 121.775 MSB = 21 = 15h LSB = 77 = 4Dh (ignore thousandths place)

Normal response

None.

Error response

In the event that the CMU detects an error in the data contained in the message, it sends a CMU_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_SET substate of state ***CMD***.

New State

The resulting state is unchanged.

A10.5.11 Message CU.indication

The VDR sends the CU.indication to indicate the CU parameter. A value of 100 (64_h) indicates 100% utilization of the channel. The CU.indication message should only be sent while the VDR is in the PROTOCOL_SET substate. The CU.indication message is transmitted at fixed 1-second intervals. The CU data is calculated according to Section A10.4.10.

Message Format

The message consists of an Extended SOLO word containing the following:

Bit	Definition	Value or Range
32	Parity	
31-29	Word identifier	101b
28-25	ID	Fh
24-21	Protocol ID	1h
20-18	Primitive ID	001b
17-9	CU	0h to 64h (0 to 100).
8-1	SAL	

Normal response

None.

Error response

In the event that the CMU detects an error in the data contained in the message, it sends a CMU_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_SET substate of state ***CMD***.

New State

The resulting state is unchanged.

A10.5.12 Message UNITDATA.confirm

The VDR sends the UNITDATA.confirm to indicate the MAC delay for a transmitted frame or that the frame has been cleared from the buffer (due to a frequency change for example). The MAC delay time is measured from the time that the frame is placed in the transmit buffer until transmission event containing that frame terminates. The resolution on the MAC delay value is 2 msec. The sequence number from the UNITDATA.request message is included in the UNITDATA.confirm message so that the CMU can explicitly correlate the request and confirm message. The CMU should ignore the data in the MAC Delay field when the Transmit status is '01'.

COMMENTARY

The maximum MAC delay value that can be represented by the two octets is 2^{16} * 2 msec = 131 secs. This exceeds the maximum TM2 value of 120 secs shown in the SARPs in Table 6-6.

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet	Parameters	Value or Range	Note
1	EGFI	F1h	
2	Primitive ID	56h	
3	Data field length MSB	00h	
4	Data field length LSB	04h	
5	Transmit Status	00h = transmitted, 01h = discarded	
6	MAC delay MSB	0h to FFh (0 to 255)	1
7	MAC delay LSB	0h to FFh (0 to 255)	1
8	sequence number	0h to FF h (0 to 255)	

Note 1: The CMU should ignore the MAC Delay field when the transmit status is 01_h.

Normal response

None.

Error response

In the event that the CMU detects an error in the data contained in the message, it sends a CMU_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_SET substate of state ***CMD***.

New State

The resulting state is unchanged.

A10.5.13 Message CHAN_CONG.indication

The VDR sends the CHAN_CONG.indication to indicate when the RF channel is congested. RF channel congestion is detected by the expiration of timer TM2. The TM2 timer is started when the frame is placed in the transmit buffer. The TM2 timer is stopped when a transmission event containing that frame occurs.

Message Format

The message consists of an Extended SOLO word containing the following:

Bit	Definition
32	Parity
31-29	"101b"
28-25	Fh
24-21	1h
20-18	"000b" (Primitive ID for CHAN_CONG SOLO word)
17-09	all bits set to zero
08-01	SAL

Parameters

None

Normal response

None.

Error response

None

Reasons for failure

None

State

This message is processed in the PROTOCOL_SET substate of state ***CMD***.

New State

The resulting state is unchanged.

A10.5.14 Message PURGE.request

The CMU sends the PURGE.request to command the VDR to purge its transmit buffer.

Message Format

The message consists of an Extended SOLO word containing the following:

Bit	Definition
32	Parity
31-29	"101b"
28-25	Fh
24-21	1h
20-18	"010b" (Primitive ID for PURGE.request SOLO word)
17-09	all bits set to zero
08-01	SAL

Parameters

None

Normal response

If, as a result of this command, the VDR purges frames from its transmit buffer, then the VDR sends a UNITDATA.confirm message for each frame as a response to an outstanding unacknowledged UNITDATA.request command previously received from the CMU.

Error response

None

Reasons for failure

None

State

This message is processed in the PROTOCOL_SET substate of state ***CMD***.

New State

The resulting state is unchanged.

A10.5.15 Vendor Reserved Primitives

Certain primitives are reserved for use by manufacturers for diagnostic, debugging or other purposes. An Extended BOP file primitive whose Primitive ID falls within the range $F0_h$ to FF_h is considered to be a vendor-reserved primitive. The type (COMMAND or DATA) of these reserved primitives is undefined.

COMMENTARY

Some vendors have expressed a desire for a dedicated Vendor reserved primitive and have been assigned a primitive ID value. Only the vendor that has been assigned that primitive ID value should use it. A vendor that desires to have a primitive ID value assigned should contact the AEEC VDL Subcommittee Secretary. The following primitive ID values have been assigned:

F0h – Honeywell
F1h – Rockwell Collins

Message Format

The message consists of one Extended BOP file of type COMMAND or DATA containing the following:

Octet	Parameters	Value or Range	Note
1	EGFI	F1h	Indicates ASIP
2	Primitive ID	F0h to FFh	Range of vendor primitives
3	Data field length MSB	-	
4	Data field length LSB	-	
5	Data Field Byte #1		
6	Data Field Byte #2		
.	.		
.	.		
.	.		
N+4	Data Field Byte #N		

Normal response

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

Vendor defined.

Error response

Vendor defined.

State

Vendor defined.

New State

Vendor defined.

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

Table A10-1 VDR - CMU Primitives

All primitives are composed of Extended BOP files except as indicated.

Command/Query Message	Primitive	Sender	Primitive ID	Type
Operational parameter request	PARAM.request	CMU	20_h	COMMAND
CMU data transfer request	UNITDATA.request	CMU	21_h	DATA
Address request	ADDR.request	CMU	22_h	COMMAND
CMU Error indication	CMU_ERROR.indication	CMU	23_h	COMMAND
Operational parameter acknowledge.	PARAM.confirm	VDR	50_h	COMMAND
VDR data transfer indication	UNITDATA.indication	VDR	51_h	DATA
Address acknowledgment	ADDR.confirm	VDR	52_h	COMMAND
VDR Error indication	VDR_ERROR.indication	VDR	53_h	COMMAND
Signal quality indication	SQP.indication	VDR	54_h	COMMAND
Channel utilization indication	CU.indication (Extended SOLO word)	VDR	001_h	*N/A*
Frame transmission confirm	UNITDATA.confirm	VDR	56_h	COMMAND
Channel congestion indication	CHAN_CONG.indication (Extended SOLO word)	VDR	000_b	N/A
Purge	PURGE.request (Extended SOLO word)	CMU	010_b	N/A
Vendor Reserved Primitives	Vendor defined	VDR/CMU	$F0_h$ to FF_h	COMMAND or DATA

Table A10-2 Error Messages

Error Condition	Sender	Error Code	Error Data
Unspecified Error	CMU/VDR	00_h	Don't care
Unrecognized PID	CMU/VDR	01_h	Offending PID
BADDATA	CMU/VDR	02_h	Offending PID
VDR transmit buffer overflow	VDR	03_h	None
Out of sequence or unexpected primitive	CMU/VDR	04_h	Offending PID

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

Table A10-3 Generic Frame Format

		Bit Number							
	Octet No.	8	7	6	5	4	3	2	1
Flag	-	0	1	1	1	1	1	1	0 (1^{st} transmitted bit in the frame)
Destination Address Field	1	22		24	25		27	A/G	0
	2	15						21	0
	3	8		Station Address				14	0
	4	1						7	0
Source Address Field	5	22		24	25		27	C/R	0
	6	15						21	0
	7	8		Station Address				14	0
	8	1						7	1
Link Control Field	9				P/F				
Information	N-2	User Data							
Frame Check Sequence	N-1	9	Most Significant Octet						16
Number	N	1	Least Significant Octet					7	8
Flag	-	0	1	1	1	1	1	1	0

ADDR.request and ADDR.confirm Encoding Examples

In the examples, the tail number and 24-bit ICAO address are consistent with DO-224***A***

Both the ADDR.request and ADDR.confirm messages contain three addresses. For the first encoded address, the aircraft tail number is N24175 whose 24-bit ICAO address is 0xA23721. The binary representation of this address is shown below. The type field for this address is '001' for bits 27-25 corresponding to the "Aircraft" type field. The A/G bit is set to '1' because the transmitter is on the ground. As this address is located in the Destination Address Field, the extension bit of each octet, bit 1, is set to '0' for all four octets.

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

1010 0010 0011 0111 0010 0001

The four octets in the Destination Address Field would be composed as:

octet 1 = 10110010 = $B2_h$
octet 2 = 00010000 = 10_h
octet 3 = 01110110 = 76_h
octet 4 = 10000100 = 84_h

The second address is the "all ones broadcast" address. The hex representation of this address is 0xFFFFFF. The type field of this address is '111' for bits 27-25 corresponding to the "All stations broadcast" type field. The A/G bit is set to '1' because the transmitter is on the ground. The extension bit of each octet, bit 1, is set to '0 for all four octets. The four octets in the Destination Address Field would be composed as:

octet 1 = 11111110 = FE_h
octet 2 = 11111110 = FE_h
octet 3 = 11111110 = FE_h
octet 4 = 11111110 = FE_h

The third address ***is*** the "all ones broadcast" address. The hex representation of this address is $FFFFFF_h$. The type field of this address is '001' for bits 27-25 corresponding to the "Aircraft" type field. The A/G bit is set to '1' because the transmitter is on the ground. The extension bit of each octet, bit 1, is set to '0' for all four octets. The four octets in the Destination Address Field would be composed as:

octet 1 = 11110010 = $F2_h$
octet 2 = 11111110 = FE_h
octet 3 = 11111110 = FE_h
octet 4 = 11111110 = FE_h

An ADDR.request message containing these addresses and their associated type fields is:

Octet	Parameters	Value
1	EGFI	$F1_h$
2	Primitive ID	22_h
3	Data field length MSB	00_h
4	Data field length LSB	$0D_h$
5	Control octet	01_h
6	Address 1, octet 1	$B2_h$
7	Address 1, octet 2	10_h
8	Address 1, octet 3	76_h
9	Address 1, octet 4	84_h
10	Address 2, octet 1	FE_h
11	Address 2, octet 2	FE_h
12	Address 2, octet 3	FE_h
13	Address 2, octet 4	FE_h
14	Address 3, octet 1	$F2_h$
15	Address 3, octet 2	FE_h

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

16	Address 3, octet 3	FE_h
17	Address 3, octet 4	FE_h

An ADDR.confirm message containing this address is:

Octet	Parameters	Value
1	EGFI	$F1_h$
2	Primitive ID	52_h
3	Data field length MSB	00_h
4	Data field length LSB	$0C_h$
5	Address 1, octet 1	$B2_h$
6	Address 1, octet 2	10_h
7	Address 1, octet 3	76_h
8	Address 1, octet 4	84_h
9	Address 2, octet 1	FE_h
10	Address 2, octet 2	FE_h
11	Address 2, octet 3	FE_h
12	Address 2, octet 4	FE_h
13	Address 3, octet 1	$F2_h$
14	Address 3, octet 2	FE_h
15	Address 3, octet 3	FE_h
16	Address 3, octet 4	FE_h

Table A10-4 Address Type Field Encoding

Bit Encoding			Description Type	Comments
27	26	25		
0	0	0	Undefined	Future Use
0	0	1	Aircraft	24-bit ICAO address
0	1	0	Undefined	Future Use
0	1	1	Undefined	Future Use
1	0	0	Ground Station	ICAO-administered
1	0	1	Ground Station	ICAO-delegated
1	1	0	Undefined	Future Use
1	1	1	All stations broadcast	All stations

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

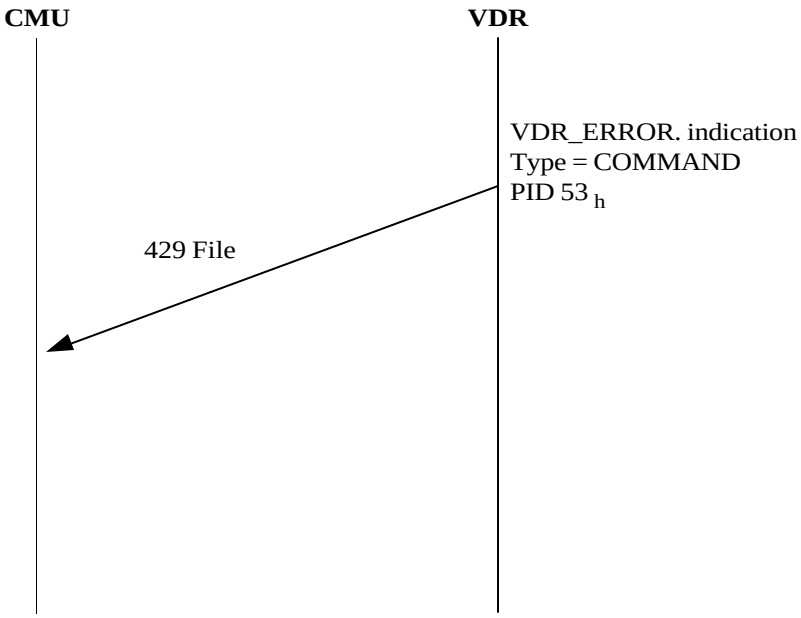


Figure A10-1 VDR Error Message

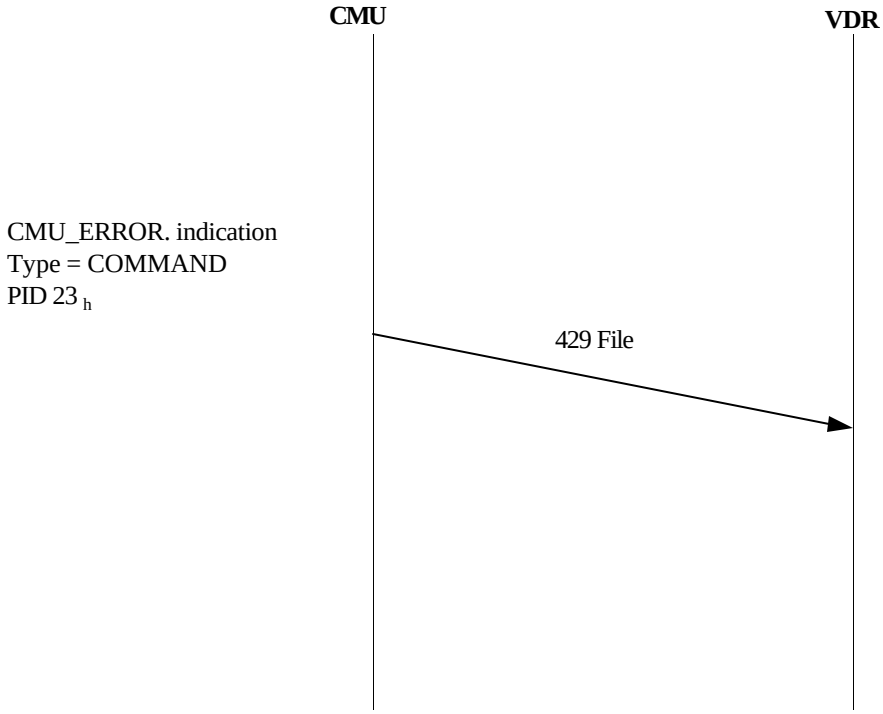


Figure A10-2 CMU Error Message

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

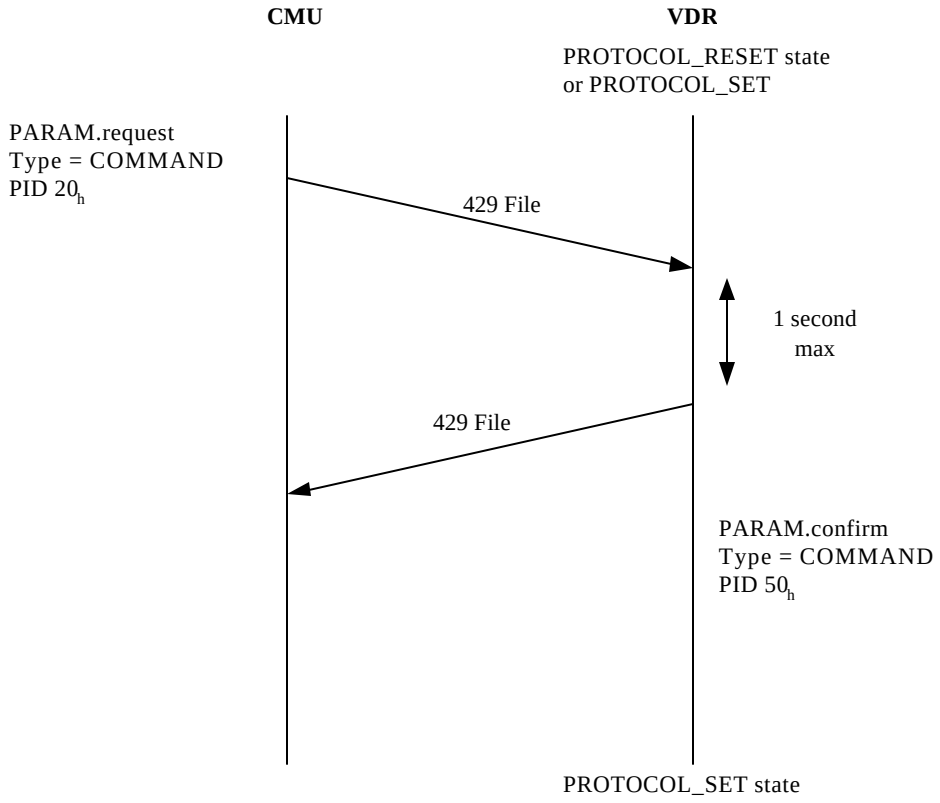


Figure A10-3 VDR Operating Parameter Data

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

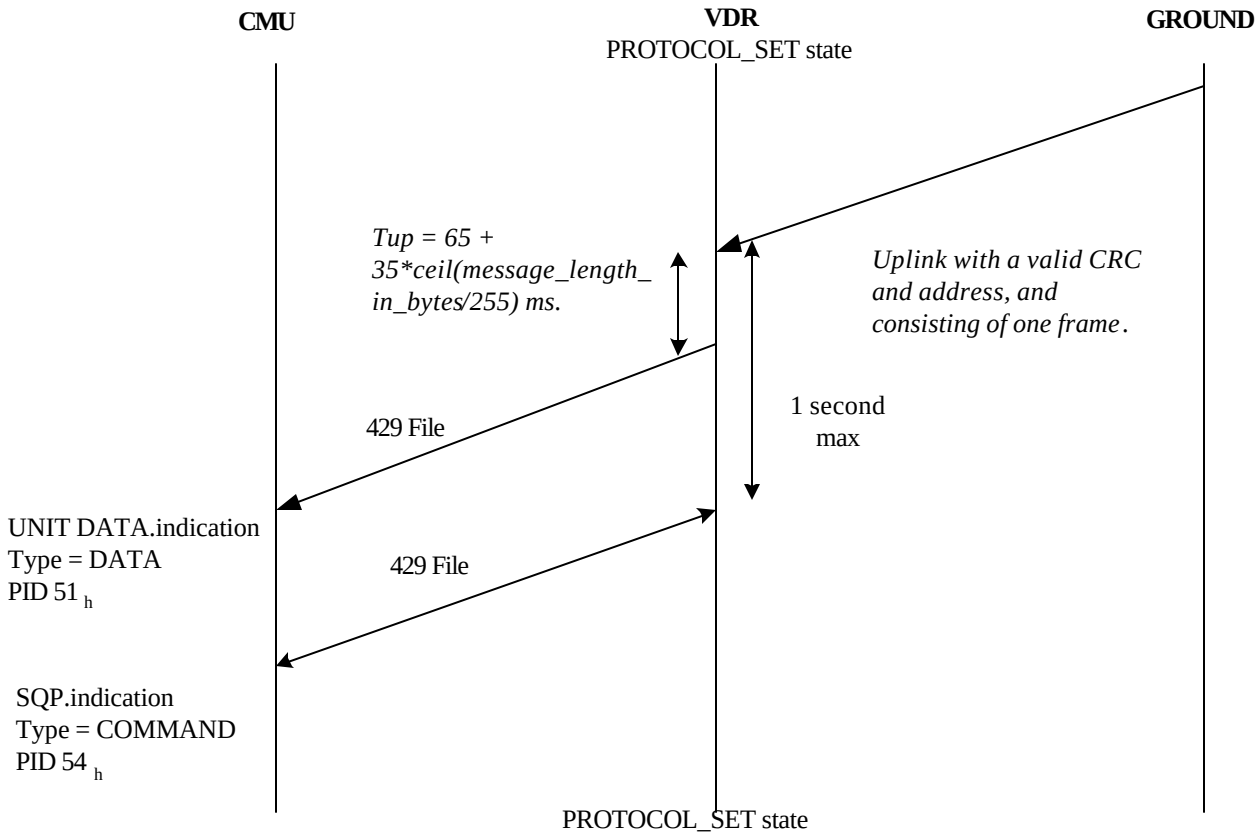


Figure A10-4 Uplink Process Reporting

Note: The UNITDATA.indication and SQP.indication should be sent in the order shown.

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

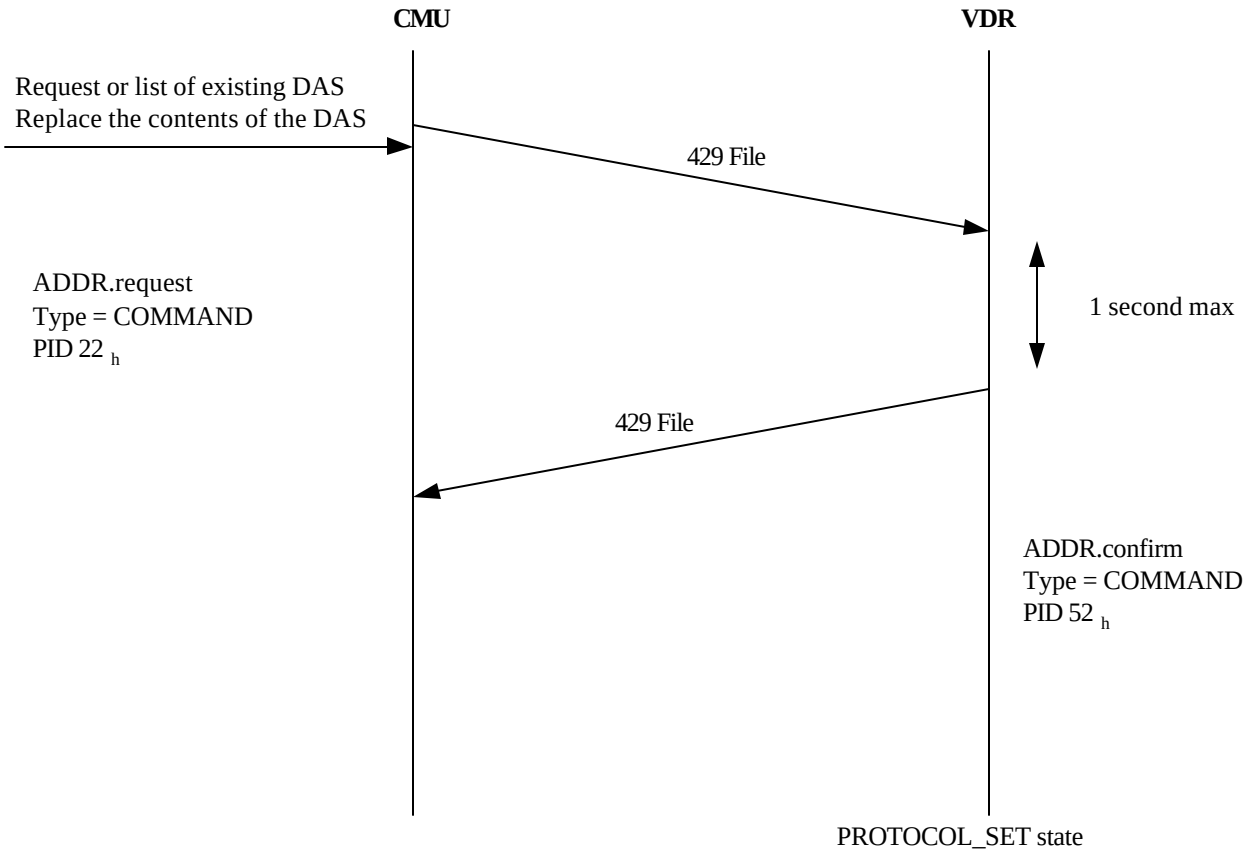


Figure A10-5 Address Request and Address Response

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

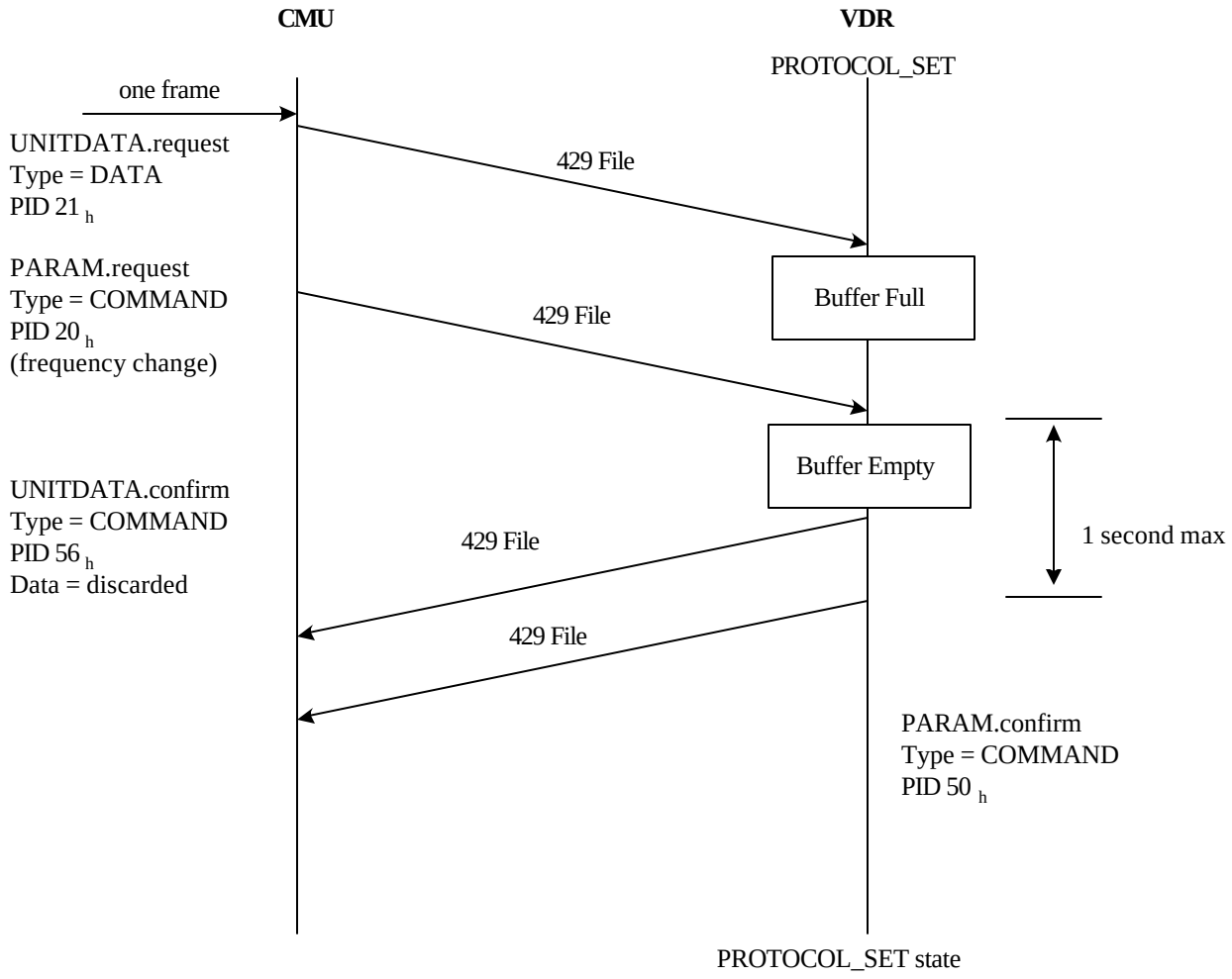


Figure A10-6 Downlink Message Handling

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

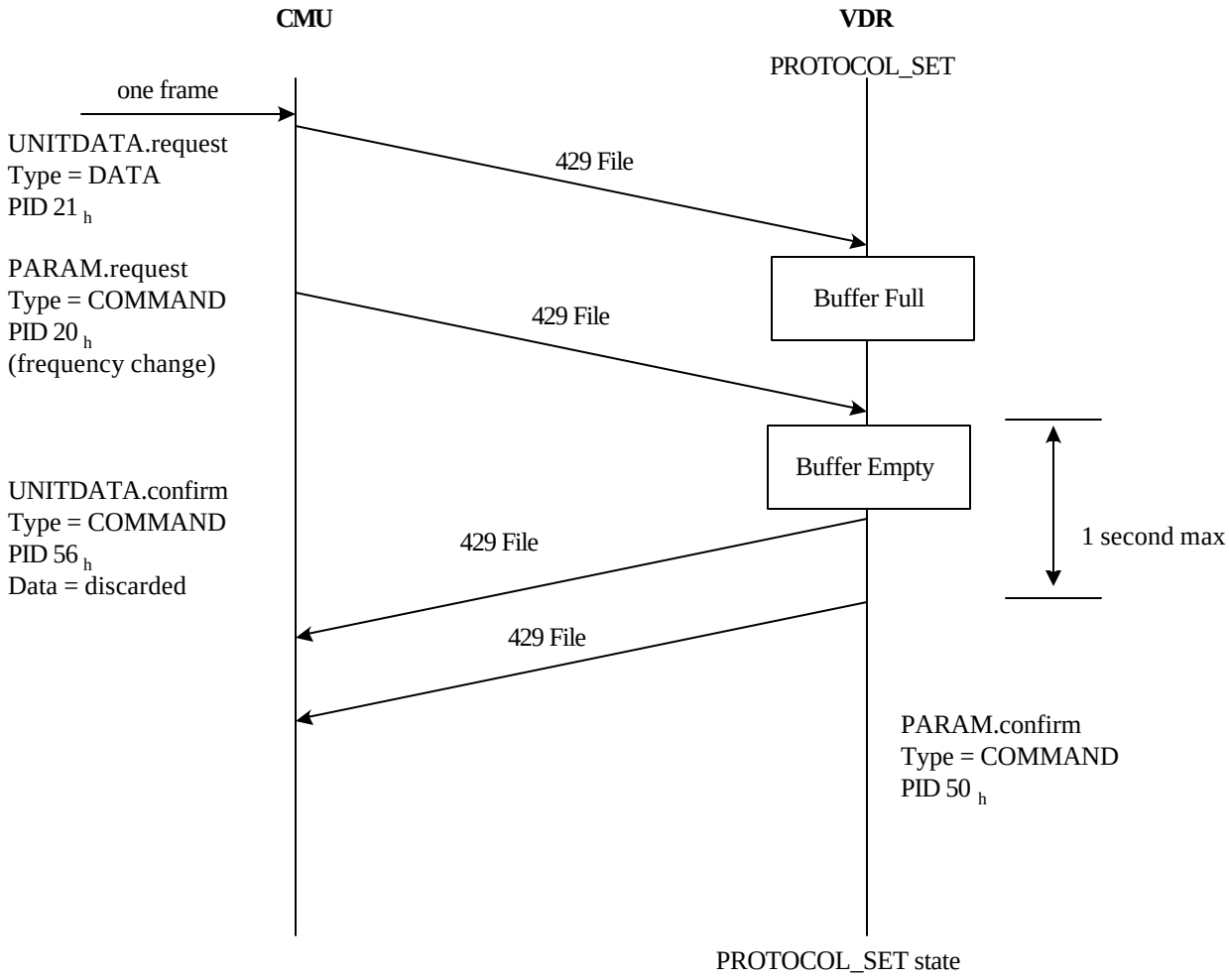


Figure A10-7 PARAM.request With an Untransmitted Buffer (See Section A10.4.16)

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

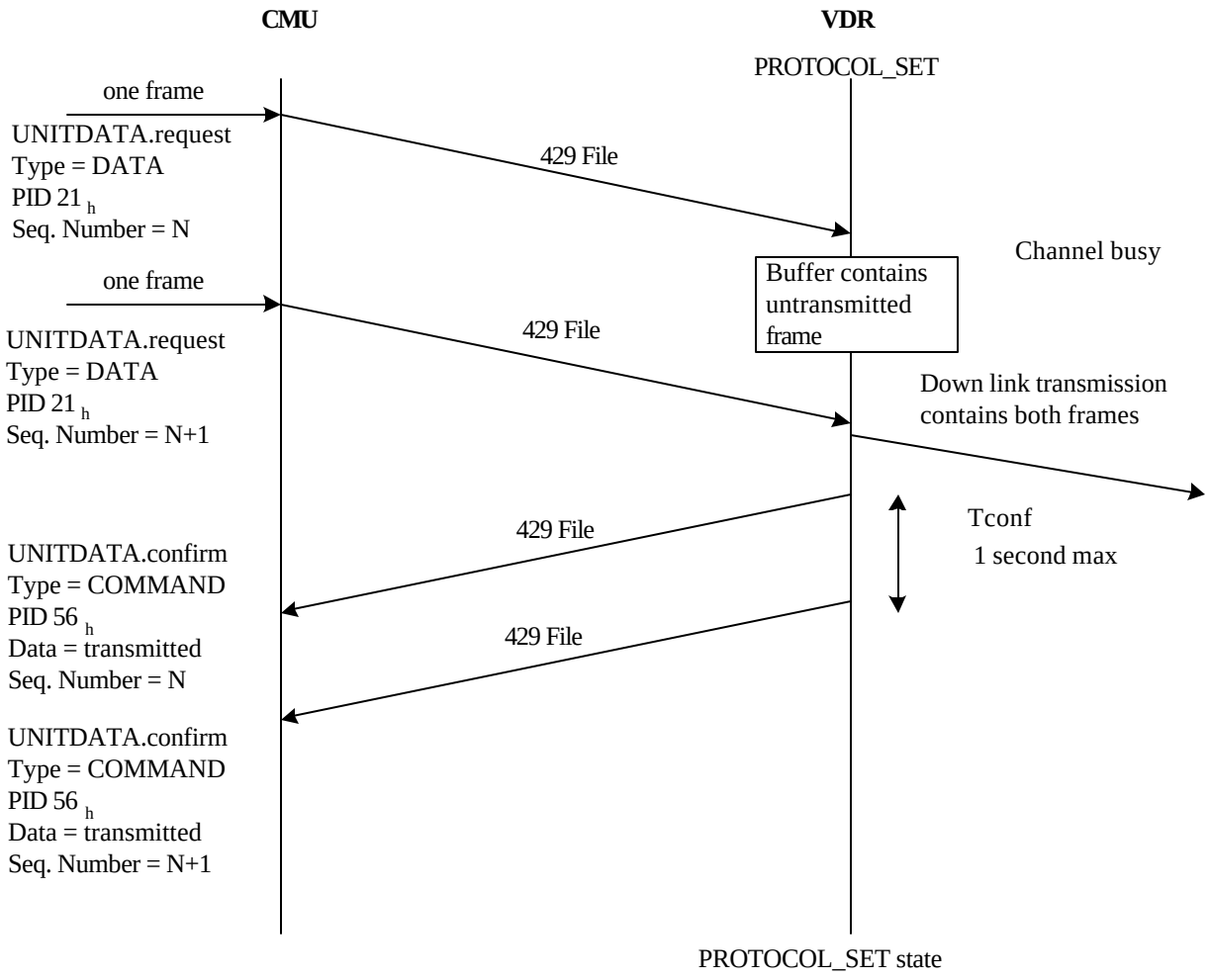


Figure A10-8 UNITDATA.request With a Non-empty Buffer

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

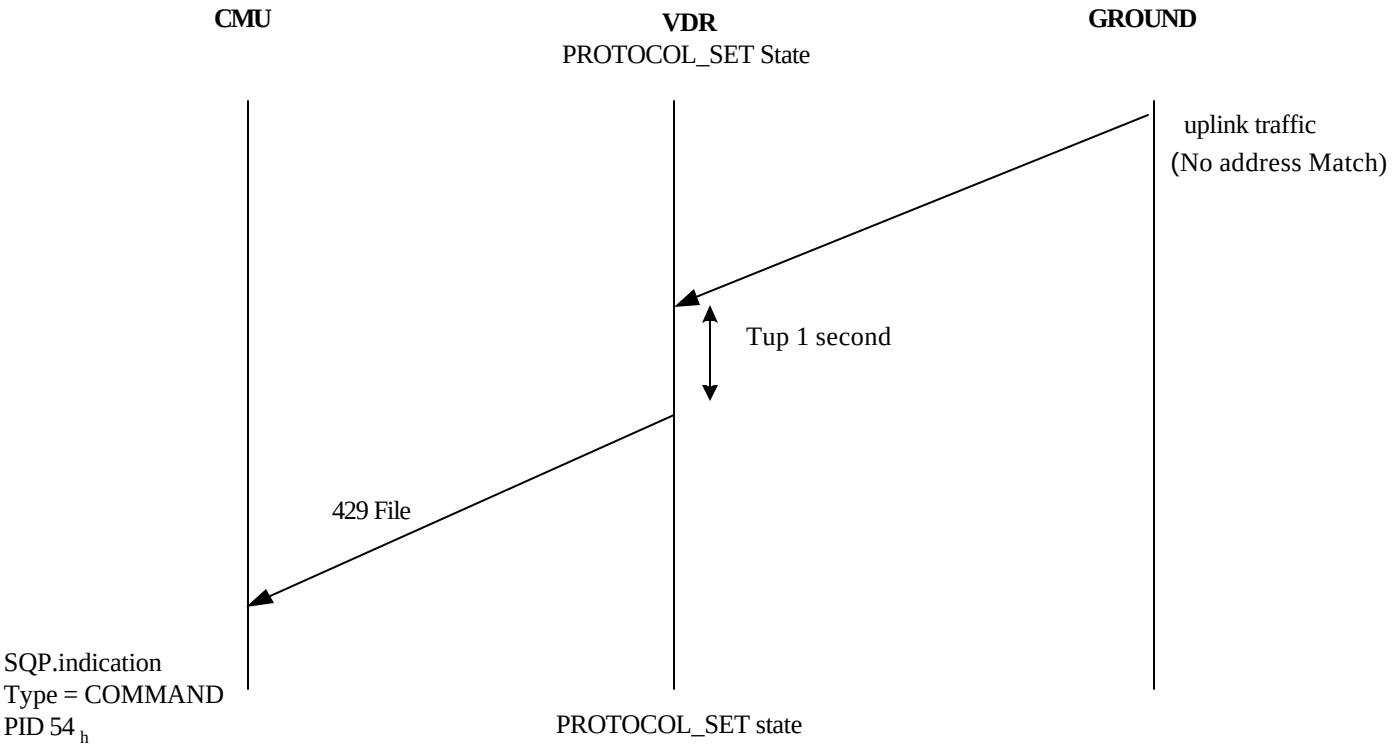


Figure A10-9 SQP Message Handling

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

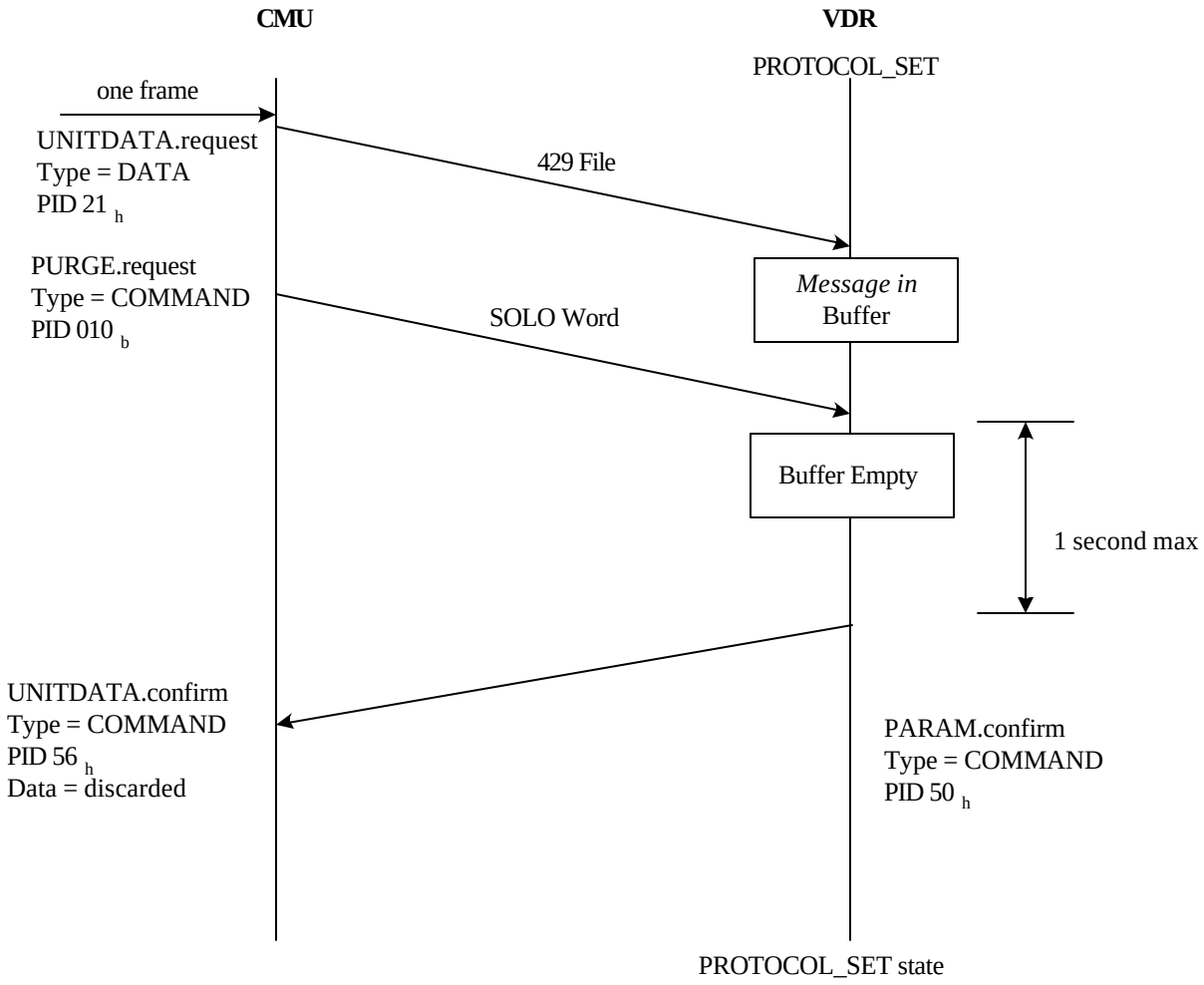


Figure A10-10 PURGE.request with an Untransmitted Buffer

ATTACHMENT 10 (cont'd)
AVLC SIMPLE INTERFACE PROTOCOL (ASIP)

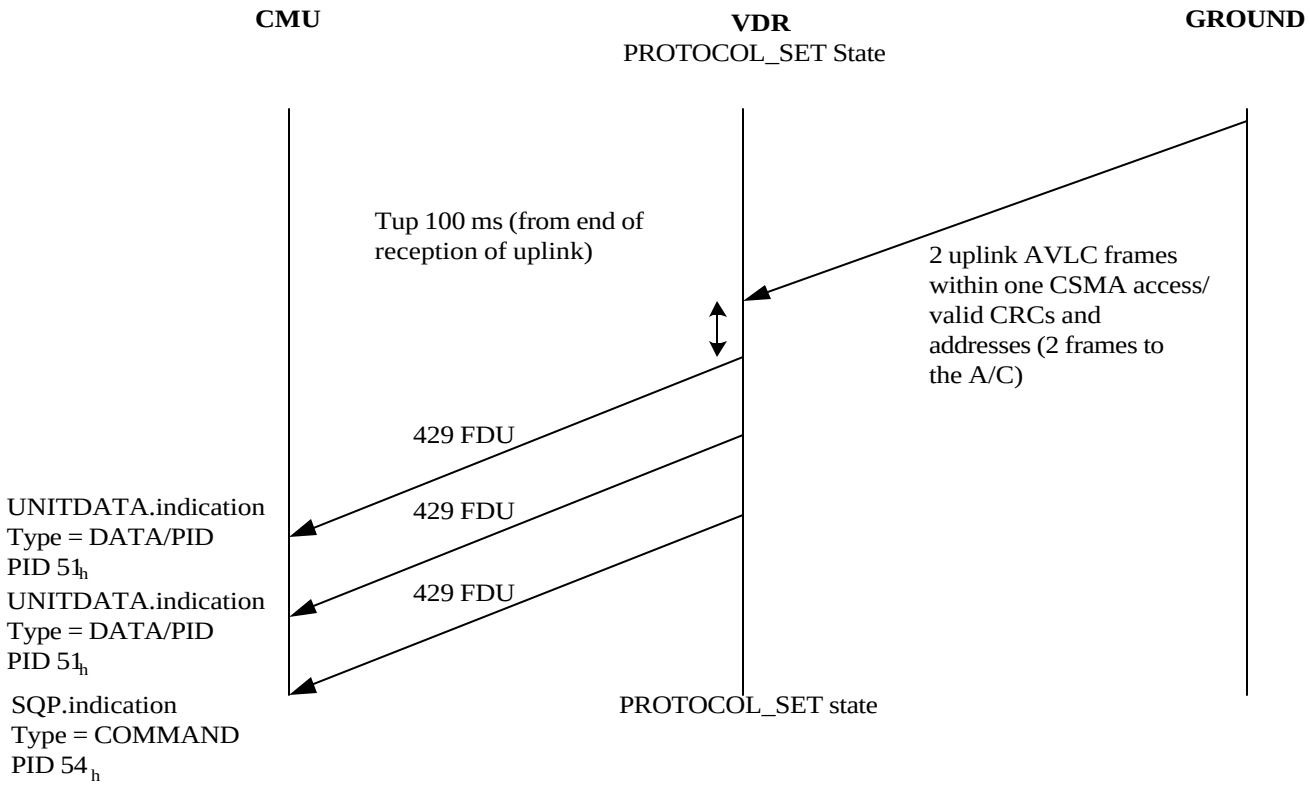


Figure A10-11 Multiple Frames Uplink Processing

Note: The UNITDATA.indication and SQP.indication should be sent in the order shown.

ATTACHMENT 11
ACARS INTERFACE PROTOCOL (ACARSIP)

A11.1 Purpose

This attachment defines the ACARS Interface Protocol (ACARSIP). This protocol is a collection of messages, methods and procedures that may be implemented in both a VHF ***Digital*** Radio (VDR) and a Communications Management Unit or Management Unit (***[***C***]***MU) to enable the pair to function as an entity in an ACARS network.

A11.2 Functional Overview

ARINC Specification 618 describes the functions, methods and procedures to be implemented by an airborne entity performing VHF ACARS operations. The protocols and procedures defined in this attachment are a particular implementation of VHF operations described in ARINC Specification 618.

The CMU and the VDR operate together to implement the functionality defined by ARINC Specification 618. A functional partitioning can be imposed between the VDR and the CMU to implement ARINC Specification 618's definition. This protocol defines a split in functionality between the VDR and the CMU subsystems and the protocols and procedures to support it.

The ARINC Specification 618 VHF Protocol has certain functions defined:

a. The ACARS Physical sub-layer performs modulation and demodulation of the ***DSB-***AM/MSK waveform. This functionality resides in the VDR.

b. The ACARS Media Access Control (MAC) sub-layer requires the use of the carrier sense multiple access (CSMA) algorithm. This sub-layer resides in the VDR.

c. The ACARS Link Management sub-layer performs all connection establishment, maintenance functions. This sub-layer resides wholly in the CMU.

d. The ACARS Data Link Service (DLS) sub-layer acts as a connectionless link over the MAC sub-layer. This sub-layer resides in both the CMU and the VDR.

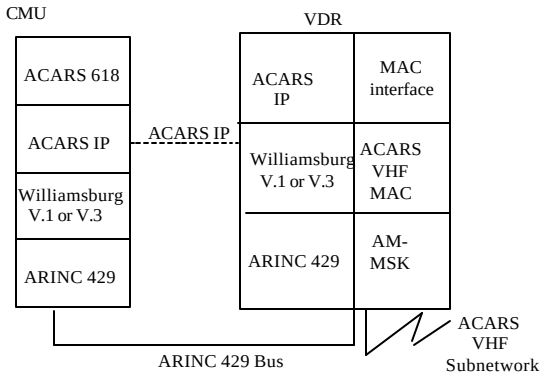


Figure A11-1 ACARSIP Functional Split

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

A11.2.1 Physical Layer Function

The VDR performs all VHF physical layer functions as defined in ARINC Specification 618, Section 4. These include, but are not limited to, modulation and demodulation of the ***DSB-***AM/MSK signal and transceiver tuning.

A11.2.2 MAC Layer Function

The VDR performs all VHF MAC layer functions as defined in ARINC Specification 618, Section 4. The channel access algorithm is defined to be Non-Persistent CSMA. The maximum pre-key length is 85 msec.

A11.3 Protocols and Procedures

A11.3.1 Protocols Overview

The ACARSIP CMU/VDR Interface Protocol consists of primitives composed only of Extended BOP files and Extended SOLO words as defined in Sections 5.1.3.1 and 5.1.3.2 respectively. As defined in Section 5.1.2.3, file primitives are of types COMMAND or DATA.

A received RF transmission contains only one ACARS block as defined in ARINC Specification 618, Section 2.1. It is preceded by a VHF Preamble (ARINC Specification 618, Section 4.2), and is followed by a BCS Suffix (ARINC Specification 618, Section 4.3). For each demodulated transmission, the VDR calculates the BCS. If the BCS is good and the block meets the address screening requirements of Section A11.4.12, then the VDR sends the block, as defined above, but stripped of the VHF Preamble, to the CMU using a single primitive.

One of the address screening criteria is that the block's address field matches one of a set of (up to) eight valid addresses. This set of addresses, referred herein as the Destination Address Set (DAS), is loaded by the CMU using a command primitive. The VDR, prior to its initialization procedure, contains a null DAS. Consequently, no message blocks are passed from the VDR to the CMU until the DAS contains valid destination addresses.

The VDR sends an SQP information for every received transmission from the ground containing a block with a valid BCS. The SQP information is used by the Link Management function, which resides in the CMU. The SQP reporting function is disabled prior to the VDR's initialization and is enabled when the CMU sends certain operational parameter data to the VDR. The VDR performs SQP reporting with a null DAS. A downlink block to be sent by the CMU is passed to the VDR and contains everything from the <SOH> word through the BCS suffix character. Before transmission of the block, the VDR affixes the VHF Preamble. Upon completion of transmission of the block, the VDR notifies the CMU that the block has been transmitted.

The CMU can command the VDR to execute an audit mode. In this mode, the VDR can be commanded to send to the CMU either:

a. All received and transmitted blocks, or

b. All transmitted blocks and all received blocks that meet the address screening criteria of Section A11.4.12.

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

In either case, data is included from the <SOH> to the BCS suffix character**,** regardless of the value of the BCS.

A11.3.2 ARINC SPECIFICATION 429 Interface Definition.

(Defined in Section 5).

A11.4 Procedures

Certain procedures should be followed to manage the VDR.

A11.4.1 VDR Initialization

Section 5 defines the CMU-to-VDR interface as providing support for multiple interface protocols. It defines the initialization procedure that is to be performed in order to bring the interface to a functional state upon reset or power up. The VDR determines its correct operating mode and determines which CMU is to be declared as primary. If in ***a*** Data mode, it then negotiates the protocol to be used with the CMU. Once this negotiation is successfully completed, normal data mode operations using the negotiated interface protocol can commence.

A11.4.1.1 PROTOCOL_NULL State

After entering 750 Data mode, but before protocol negotiation has succeeded, the VDR should be in the PROTOCOL_NULL state. This is a transitional state in which the VDR communicates with the CMU during the protocol negotiation process using command primitives defined in Section 5.

Contents of VDR's transmitted Label 270 status word

Protocol Status bit = "0"
Download Request bit = "0"

A.11.4.1.2 PROTOCOL_RESET State

After a protocol has been successfully negotiated, but before operating parameters have been loaded, the VDR should be in the PROTOCOL_RESET state. All buffers are flushed, and all operating parameters (mode, frequency, etc.) are set to their default values. The DAS is NULL and therefore no uplink messages are passed to the CMU. SQP reporting is disabled.

Contents of VDR's transmitted Label 270 status word:

Protocol Status bit = "1"
Download Request bit = "1"

A11.4.1.3 PROTOCOL_SET State

Once the PARAM.request message has been received and validated by the VDR, it should be in the PROTOCOL_SET state. SQP reporting is enabled. Uplink messages are only sent once the DAS has been loaded on command by the CMU.

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

Contents of VDR's transmitted Label 270 status word:

Protocol Status bit = "1"
Download Request bit = "0"

A11.4.2 VDR Periodic Reporting

The VDR periodically sends broadcast words to the CMU to convey status information. This is defined in Section 5.

A11.4.3 CMU Periodic Reporting

The CMU periodically sends broadcast words to the VDR to convey status information. This is defined in Section 5.

A11.4.4 VDR Error Message

If the VDR experiences a protocol error during its operation with the CMU, the VDR should send a VDR_ERROR.indication message.

A11.4.5 CMU Error Message

If the CMU experiences a non-fatal protocol error during its operation with the VDR, the CMU should send a CMU_ERROR.indication message.

A11.4.6 VDR Operating Parameter Data

If the VDR receives a PARAM.request message from the active CMU, the VDR should transmit PARAM.request message is used to set all operating parameters for the VDR including operating frequency, modulation, and pre-key. The VDR, upon *sending a PARAM.confirm message*, should transition to the PROTOCOL_SET protocol state.

COMMENTARY

The only primitive available to the CMU to query the VDR for a list of its operational parameters is the PARAM.request primitive. As the VDR responds with a PARAM.confirm message to every instance of a PARAM.request message, the content of the PARAM.confirm message can be used by the CMU to indicate error conditions or unsupported parameters in the VDR. For example, if the CMU attempts to set the Modulation format to 2400 bps ***DSB-AM/MSK*** and the resulting PARAM.confirm message shows the Modulation format to be 31.5 kbps D8PSK, the CMU can infer that the feature is unsupported (or unavailable) in the VDR.

In the event that the VDR cannot set the operating parameters to the values requested by the CMU in a PARAM.request message, it should not declare an error event, but should continue to function normally using the values it reported in the PARAM.confirm message it sent to the CMU. The CMU should make a determination if the mismatch in the contents of the PARAM.request and the PARAM.confirm messages is sufficient to warrant a VDR reset or failure declaration.

A11.4.7 Signal Quality Parameter Reporting

The VDR should send to the CMU an SQP SOLO word for every received transmission from the ground containing a block with a valid BCS. SQP reporting is enabled only while the VDR is in the PROTOCOL_SET state.

A11.4.8 Address Request

In order for the CMU to receive or transmit any blocks, it sends a message to the VDR to set the contents of the DAS. The ADDR.request message is sent by the CMU to the VDR to set the contents of the DAS.

The VDR's DAS should be able to contain at least eight addresses. As any addresses sent via this message entirely replaces the DAS's contents, the CMU can set the DAS to NULL by sending a NULL address list.

The CMU should not transmit a block without setting the DAS, because the VDR is not able to forward the acknowledgment to the CMU with a null DAS.

A11.4.9 Address Confirm

The VDR sends an ADDR.confirm message to the CMU containing a list of all currently loaded addresses. The VDR sends this message in response to an ADDR.request message from the CMU within one second of its receipt.

A11.4.10 Downlink Message Handling

The CMU sends to the VDR a UNITDATA.request message. The content of the message contains all information necessary to compose one block, and includes everything from the <SOH> character through the BCS Suffix character**,** including BCS calculation. The VDR affixes the VHF Preamble prior to transmission of the block.

The VDR queues only one message block for transmission at a time. Within one second of emptying the transmit buffer of this message (as the result of either a successful transmission of the block, overwrite of the block, or a commanded purge), the VDR sends the CMU a UNITDATA.confirm message.

It is possible that channel conditions could delay the VDR's CSMA algorithm from transmitting the message. The VDR persists in trying to transmit the queued message. The CMU is provided two methods to purge the untransmitted message. A PURGE.request message may be issued by the CMU to command the VDR to purge the outstanding message from its buffer. Alternatively, the CMU may send a new UNITDATA.request message, which overwrites the untransmitted message in the VDR's transmit queue. In either case, the VDR indicates which event occurred, either a purge or overwrite, by responding with a UNITDATA.confirm message once the buffer is actually emptied.

A11.4.11 Uplink Message Handling

If a received block has a valid BCS, and meets the address screening requirements of Section A11.4.12, then the VDR sends to the CMU a UNITDATA.indication message within one second of receiving the block. The content of the message contains everything from the <SOH> character through the BCS Suffix character**.**

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

The VDR strips the VHF Preamble from the block prior to sending the UNITDATA.indication message to the CMU.

A11.4.12 Address Screening

Before a received block can be sent to the CMU, it should meet the following:

a. The Uplink/Downlink Block Identifier field should indicate that the block is an uplink block. It should consist of an "A" - "Z" (4/1 - 5/A) or "a" - "z" (6/1 - 7/A) or NUL (0/0) single character.

b. The address field should match one of the addresses previously loaded into the DAS by the CMU. The address should conform to the ISO-5 character encoding scheme and transmission order shown in ARINC Specification 618, Section 2.2.3.

COMMENTARY

In order for squitter uplink blocks to be sent to the CMU, the squitter all-call address is to be explicitly loaded into the DAS by the CMU.

When audit mode is enabled (per Section A11.4.14) message blocks may be forwarded regardless of the defined address screening.

Table A11-3 shows a generic block format.

A11.4.13 Error Handling and Recovery

The CMU, through examination of the PARAM.confirm message or by other indications, may determine that the VDR is in an unknown state. The CMU can command the VDR to enter the PROTOCOL_RESET state by sending a PR_SET.request message (Section 5.3.2.1). The VDR transitions to the PROTOCOL_RESET state when the PR_SET.request message is received. Either the VDR or the CMU can send an ERROR.indication message as the result of various non-fatal error conditions that may occur. The content of the ERROR.indication message provides an error code as well as an octet for an error data field. If the error occurred as the result of processing a received primitive, due to bad data length for example, the error data field contains the PID of the offending primitive.

No explicit means is provided the VDR for fatal error recovery because the nature of a fatal error may prevent the VDR from recovering. In the event that the VDR resets itself to either a ***d***ata mode or other mode of operation, the content of the VDR's Label 270 word unambiguously indicates to the CMU its current status and mode of operation.

A11.4.14 Audit Mode

The VDR can perform an audit mode function. In this mode the VDR sends to the CMU either: all received blocks, or all received blocks meeting the address screening requirements of Section A11.4.12, whether the BCS is valid or not. The information is sent to the CMU in an AUDITDATA.indication message and includes all data in the received block from the <SOH> through the BCS suffix characters.

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

This mode is enabled or disabled upon command by the CMU using an AUDIT.request message. The content of the message indicates which form of the audit mode is requested. Within 1 second of receipt of the message the VDR responds with an AUDIT.confirm message, indicating whether audit mode is enabled or disabled. While audit mode is enabled, the VDR continues to perform normal ACARS data transfers.

A11.4.15 Subnetwork Statistics Data Function

The VDR can perform a subnetwork statistics data gathering function. When this mode is enabled the VDR collects the data identified in ARINC Specification 618, Section 5.10.2, at the period indicated in the request message. The information is sent to the CMU in a STAT.indication message periodically as indicated in the STAT.request message.

This mode is enabled or disabled upon command by the CMU using a STAT.request message. The content of the message indicates the reporting period and whether to enable or disable the reporting. Within *one* second of receipt of the message the VDR responds with a STAT.confirm message indicating whether the statistics function is enabled or disabled.

A11.5 Primitives

The primitives that are transferred between the VDR and CMU are used for all command and data transfer.

Primitives are of three generic types:

REQUEST The REQUEST primitive is passed between the VDR and CMU when a response may be required. Primitives of this type have the form XXX.request.

CONFIRM The CONFIRM primitive is passed between the VDR and CMU in response to a previous REQUEST primitive. Primitives of this type have the form XXX.confirm.

INDICATION The INDICATION primitive is passed between the VDR and the CMU to convey unsolicited information such as user data or error messages. Primitives of this type have the form XXX.indication.

The general format of all the messages exchanged using the Extended BOP file transfer between the CMU and VDR is as defined in Section 5.1.3.1. For primitives composed of Extended SOLO words, the format is as defined in Section 5.1.3.2.

A11.5.1 Message PARAM.request

The PARAM.request message is sent by the CMU to set all operating parameters for the VDR, including operating frequency and modulation mode.

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

Octet	Parameters
1	EGFI
2	Primitive ID
3	Data field length MSB
4	Data field length LSB
5	Frequency MSB
6	Frequency LSB
7	Modulation format
8	Pre-key value

Parameters

EGFI
$F2_h$

Primitive ID field
20_h

Data field length MSB
00_h

Data field length LSB
04_h

Frequency MSB (tens, ones of freq. in MHz)
18 to 36 (12_h to 24_h) for 118 through 136 MHz.

Frequency LSB (tenths, hundredths of freq. in MHz, ignore 1000ths) 00 to 97 (00_h to 61_h) for xxx.000 through xxx.975 MHz.

Example: freq. = 121.775
MSB = 21 = 15_h
LSB = 77 = $4D_h$
(ignore thousandths place)

Modulation format (only 2400 bps ***DSB-AM/MSK*** is supported)

00_h for 2400 bps ***DSB-AM/MSK***.

Pre-key value
0 to 85 ms, default value of 37 ms (25_h),
1 ms step size

COMMENTARY

Pre-key requirements are a summation of the transmitter ramp up time of 2 msec (See Section 4.2.6.1) and the Remote Ground Station (RGS) Automatic Gain Control (AGC) and Synchronization time which

is defined to be 35 msec or less per ARINC Specification 618. As a result, the total pre-key default value should be 37 msec.

Normal response

The VDR responds to this message with a PARAM.confirm message containing the VDR's active values for all the above parameters.

Error response

In the event the VDR detects an error in the data contained in the message it sends an VDR_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_RESET and PROTOCOL_SET substates of state ***CMD***.

New State

The resulting state is unchanged.

A11.5.2 Message UNITDATA.request

The UNITDATA.request message is sent by the CMU to send ACARS data to the VDR. It contains one block to be transmitted by the VDR in the next available transmission.

Message Format

The message consists of one Extended BOP file of type DATA containing the following:

Octet	Parameters
1	EGFI
2	Primitive ID
3	Data field length MSB
4	Data field length LSB
5	Data field byte #1
6	Data field byte #2
.	.
.	.
.	.
N+4	Data field byte #N

Parameters

EGFI
$F2_h$

Primitive ID field
21_h

Data field length MSB
MSB ($0\text{-}FF_h$)

Data field length LSB
LSB ($0\text{-}FF_h$)

Data field bytes
All bytes of data to be sent are consecutively ordered.

Normal response

The VDR responds with a UNITDATA.confirm message when the block clears its transmit buffer. This can occur as the result of three events:

a. the successful transmission of the block, or
b. the receipt of a PURGE.request message from the CMU.
c. the receipt of a UNITDATA.request message from the CMU that overwrites the existing buffer.

Error response

In the event the VDR detects an error in the data contained in the message, it sends a VDR_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_SET substate of state ***CMD***.

New State

The resulting state is unchanged.

A11.5.3 Message ADDR.request

The ADDR.request message is sent by the CMU to manage addresses used by the VDR for address screening. It is used by the CMU to set all addresses in the DAS. Any addresses set using this primitive completely replace the existing contents of the DAS.

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

Thus, if the CMU wishes to delete all entries in the DAS it can do so by sending a NULL table to the VDR with octet 5 set to 00_h.

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet	Parameters
1	EGFI
2	Primitive ID
3	Data field length MSB
4	Data field length LSB
5	N, number of addresses contained in the file
6	Address 1, character 1
7	Address 1, character 2
8	Address 1, character 3
9	Address 1, character 4
10	Address 1, character 5
11	Address 1, character 6
12	Address 1, character 7
13	Address 2, character 1
14	Address 2, character 2
15	Address 2, character 3
.	.
.	.
.	.
N*7+5	Address N, character 7

Parameters

EGFI
$F2_h$

Primitive ID field
22_h

Data field length MSB
00_h

Data field length LSB
01_h to 39_h
01_h accounts for the address number octet,
39_h accounts for 8*7+1 octets.

N
00_h to 08_h (0 to 8) The number of address contained in the file.

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

Address

The seven octets of the address compose the ISO-5 characters shown in the seven-unit character coding scheme in ARINC Specification 618, Section 2.3.3.

Normal response

The VDR responds with a ADDR.confirm message within one second of receipt of the message.

Error response

In the event the VDR detects an error in the data contained in the message, it sends VDR_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_RESET and PROTOCOL_SET substates of state ***CMD***.

New State

The resulting state is unchanged.

A.11.5.4 Message CMU_ERROR.indication

The CMU_ERROR.indication message is sent by the CMU to indicate general error conditions.

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet	Parameters
1	EGFI
2	Primitive ID
3	Data field length MSB
4	Data field length LSB
5	Error code
6	Error data

Parameters

EGFI
$F2_h$

Primitive ID field
23_h

Data field length MSB
00_h

Data field length LSB
02_h

Error code
see Table A11-2.

Error data
see Table A11-2.

Normal response

None.

A.11.5.4 Message CMU_ERROR.indication (cont'd)

Error response

In the event the VDR detects an error in the data contained in the message, it sends a VDR_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_RESET and PROTOCOL_SET substates of state ***CMD***.

New State

The resulting state is unchanged.

A11.5.5 Message AUDIT.request

The AUDIT.request message is sent by the CMU to command the VDR to enter or exit audit mode. Two forms of audit mode may be commanded by the CMU: un-screened or screened. When performing the unscreened audit mode the VDR sends all received and transmitted blocks to the CMU. When performing the screened audit mode the VDR sends all transmitted blocks and all received blocks that meet the address screening requirements of Section A11.4.12.

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet	Parameters
1	EGFI
2	Primitive ID
3	Data field length MSB
4	Data field length LSB
5	Command

Parameters

EGFI
$F2_h$

Primitive ID field
26_h

Data field length MSB
00_h

Data field length LSB
01_h

Command
00_h = disable audit mode.
01_h = enable un-screened audit mode.
02_h = enable screened audit mode.

Normal response

The VDR responds within one second of receipt with an AUDIT.confirm message.

Error response

In the event the VDR detects an error in the data contained in the message, it sends an VDR_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_SET substates of state ***CMD***.

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

New State

The resulting state is unchanged.

A11.5.6 Message PARAM.confirm

The PARAM.confirm message is sent by the VDR as the result of a PARAM.request message. It returns information to the CMU about the state of the VDR operation and the contents of its operational parameters.

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet	Parameters
1	EGFI
2	Primitive ID
3	Data field length MSB
4	Data field length LSB
5	Frequency MSB
6	Frequency LSB
7	Modulation format
8	Pre-key value

Parameters

EGFI
F2h

Primitive ID field
50_h

Data field length MSB
00_h

Data field length LSB
04_h

Frequency MSB (tens, ones of freq. in MHz)
18 to 36 (12h to 24h) for 118 through 136 MHz.
Frequency LSB (tenths, hundredths of freq. in MHz, ignore 1000ths)
00 to 97 (00_h to 61_h) for xxx.000 through xxx.975 MHz.

Example: freq. = 121.775
MSB = 21 = 15_h
LSB = 77 = $4D_h$ (ignore thousandths place)

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

Modulation format
00_h for 2400 bps ***DSB-AM/MSK***,
01_h for 31.5 kbps D8PSK.

Pre-key length ms
0 to 85 ms (19_h), 1 ms step size

Normal response

None.

Error response

In the event the CMU detects an error in the data contained in the message, it sends a CMU_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_RESET and PROTOCOL_SET substates of state ***CMD***.

New State

The resulting state is the PROTOCOL_SET substate of ***CMD***.

A11.5.7 Message UNITDATA.indication

The UNITDATA.indication message is sent by the VDR to send ACARS data to the CMU.

Note: The UNITDATA.indication and SQP.indication should be sent in the order shown in Figure A11-4

Message Format

The message consists of one Extended BOP file of type DATA containing the following:

Octet	Parameters
1	EGFI
2	Primitive ID
3	Data field length MSB
4	Data field length LSB
5	Data field byte #1, (first character of uplink <SOH>)

6	Data field byte #2
.	.
.	.
.	.
N+4	Data field byte #N, (last character of uplink, BCS suffix Character)

Parameters

EGFI
$F2_h$

Primitive ID field
51_h

Data field length MSB
MSB (0 to FF_h)

Data field length LSB
LSB (0 to FF_h)

Data field bytes
All bytes of data to be sent are consecutively ordered.

Normal response

None

Error response

In the event the CMU detects an error in the data contained in the message, it sends an CMU_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_SET substate of state ***CMD***.

New State

The resulting state is unchanged.

11.5.8 Message ADDR.confirm

The ADDR.confirm message is sent by the VDR to indicate the contents of its Destination Address Set. It is sent within one second of the receipt of a ADDR.request message.

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet	Parameters
1	EGFI
2	Primitive ID
3	Data field length MSB
4	Data field length LSB
5	N, number of addresses contained in the file
6	Address 1, character 1
7	Address 1, character 2
8	Address 1, character 3
9	Address 1, character 4
10	Address 1, character 5
11	Address 1, character 6
12	Address 1, character 7
13	Address 2, character 1
14	Address 2, character 2
15	Address 2, character 3
.	.
.	.
.	.
N*7+5	Address N, character 7

Parameters

EGFI
F2h

Primitive ID field
52_h

Data field length MSB
00_h

Data field length LSB
01_h to 39_h
01_h accounts for the address number octet,
39_h accounts for 8*7+1 octets.

N
00_h to 08_h (0 to 8 addresses)

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

Address

The seven octets of the address compose the ISO-5 characters shown in the seven-unit character coding scheme in ARINC Specification 618, Section 2.3.3.

Normal response

None.

Error response

In the event the CMU detects an error in the data contained in the message, it sends a CMU_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_RESET and PROTOCOL_SET substates of state ***CMD***.

New State

The resulting state is unchanged.

A11.5.9 Message VDR _ ERROR.indication

The VDR_ERROR.indication message is sent by the VDR to indicate general error conditions.

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet	Parameters
1	EGFI
2	Primitive ID
3	Data field length MSB
4	Data field length LSB
5	Error code
6	Error data

Parameters

EGFI

$F2_h$

Primitive ID field
53_h

Data field length MSB
00_h

Data field length LSB
02_h

Error code
see Table A11-2.

Error data
see Table A11-2.

Normal response

None.

Error response

In the event the CMU detects an error in the data contained in the message, it sends an CMU_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_RESET and PROTOCOL_SET substates of state ***CMD***.

New State

The resulting state is unchanged.

A11.5.10 Message SQP.indication

The SQP.indication message is sent by the VDR and contains a quality of service report for the latest received transmission whose BCS is good. A ground station transmitted message is indicated by the content of the Uplink/Downlink Block Identifier field as defined in ARINC Specification 618, Section 2.3.6. The SQP.indication message should only be sent while the VDR is in the PROTOCOL_SET state.

The information contained in this message, the lower five bits of the mode character of the message from the transmitting ground station and the SQP of that transmission, can be used by the Link Management function in the CMU for link control procedures.

Note: The UNITDATA.indication and SQP.indication should be sent in the order shown in Figure A11-4.

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

Message Format

The message consists of an Extended SOLO word containing the following:

Bit	Definition
32	Parity
31-29	"101_b"
28-25	F_h
24-21	2_h
20-18	"000_b" (Primitive ID for SQP SOLO word)
17-13	Lower five bits of the received Mode Character.
12-09	SQP value (0_h to F_h (0 to 15), quality of service indicator, where 0 = poorest quality, 15 = best quality.)
08-01	SAL

NOTE: As only uplink messages generate SQP reports, only the lower five bits of the mode character are needed for unambiguous determination of the sender (See ARINC Specification 618, Attachment 6).

Parameters

Mode Character
Lower five bits of the uplink mode character except when mode character is 2, then this field is set to 1Fh.

SQP Value
Quality of service (signal strength) of uplink. Range 0 to 15 (0 to Fh), where 0 = poorest, 15 = best quality.

The SQP value should be determined from the RF signal strength using the following formula:

if (PdBm ≤ -98), then SQP = 0.

if (-98 < PdBm < -27) then SQP = INT(((100+PdBm)/5) + 0.5)

if (P ≥ -27), then SQP = 15

The signal strength measurement should be accurate to ±7 dB and monotonic.

Normal response

None.

Error response

None.

Reasons for failure

None.

State

This message is processed in the PROTOCOL_SET substate of state ***CMD***.

New State

The resulting state is unchanged.

A11.5.11 Message UNITDATA.confirm

The UNITDATA.confirm message is sent by the VDR to indicate that a previously queued block has cleared the transmit buffer. This can occur as the result of three events:

a. the receipt of a PURGE.request message from the CMU.

b. the transmission of the block.

c. the receipt of a UNITDATA.request message from the CMU overwriting the non-transmitted contents of the transmit buffer.

NOTE: If the receipt of a PURGE.request message does not result in the purge of the transmit buffer, then a UNITDATA.confirm message is not sent.

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

A11.5.11 Message UNITDATA.confirm (cont'd)

Octet	Parameters
1	EGFI
2	Primitive ID
3	Data field length MSB
4	Data field length LSB
5	Data field octet

Parameters

EGFI
F2h

Primitive ID field
55_h

Data field length MSB
00_h

Data field length LSB
01_h

Data field
00_h = Message not sent (purged)
01_h = Message sent
02_h = Transmit buffer overwritten.

Normal response

None

NOTE: Else, it sends an ERROR.indication message.

Error response

In the event the CMU detects an error in the data contained in the message, it sends a CMU_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_SET substate of state ***CMD***.

New State

The resulting state is unchanged.

A11.5.12 Message PURGE.request

The PURGE.request message is sent by the CMU to command the VDR to immediately purge its transmit buffer.

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet Parameters

1	EGFI
2	Primitive ID
3	Data field length MSB
4	Data field length LSB

Parameters

EGFI
$F2_h$

Primitive ID field
25_h

Data field length MSB
00_h

Data field length LSB
00_h

Normal response

None.

NOTE: If as a result of this command the VDR purges a block from its transmit buffer, then the VDR sends a UNITDATA.confirm message as a response to an outstanding unacknowledged UNITDATA.request command previously received from the CMU.

Error response

In the event the VDR detects an error in the data contained in the message, it sends a VDR_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_SET substate of state ***CMD***.

New State

The resulting state is unchanged.

A11.5.13 Message AUDIT.confirm

The AUDIT.confirm message is sent by the VDR to indicate that an error free AUDIT.request message has been received. It is sent within one second of receipt of the AUDIT.request message.

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet	Parameters
1	EGFI
2	Primitive ID
3	Data field length MSB
4	Data field length LSB
5	Command

Parameters

EGFI
$F2_h$

Primitive ID field
56_h

Data field length MSB
00_h

Data field length LSB
01_h

Command
00_h = audit mode disabled.
01_h = un-screened audit mode enabled.
02_h = screened audit mode enabled.

Normal response

None.

Error response

In the event the CMU detects an error in the data contained in the message, it sends an CMU_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_SET substate of state ***CMD***.

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

New State

The resulting state is unchanged.

A11.5.14 Message AUDITDATA.indication

The AUDITDATA.indication message is sent by the VDR to send audit data to the CMU. The data is sent anytime a block is received by the VDR, whether uplink or downlink, and whether the BCS is valid or not.

Message Format

The message consists of one Extended BOP file of type DATA containing the following:

Octet	Parameters
1	EGFI
2	Primitive ID
3	Data field length MSB
4	Data field length LSB
5	Data field byte #1, (first character of uplink <SOH>)
6	Data field byte #2
.	.
.	.
.	.
N+4	Data field byte #N, (last character of uplink, BCS suffix Character)

Parameters

EGFI
F2h

Primitive ID field
57_h

Data field length MSB
MSB (0 to FF_h)

Data field length LSB
LSB (0 to FF_h)

Data field bytes
All bytes of data to be sent are consecutively ordered.

Normal response

None.

Error response

In the event the CMU detects an error in the data contained in the message, it sends an ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_SET substate of state ***CMD***.

New State

The resulting state is unchanged.

A11.5.15 Message STAT.request

The STAT.request message is sent by the CMU to command the VDR to enable or disable the statistics data reporting. This message is also used to change the reporting interval.

The following reporting mechanisms are identified:

a. Periodic statistic reporting mode: The VDR gathers data for the indicated period. After each period elapses it sends a report containing the data to the CMU using a STAT.indication message.

b. Single statistic reporting mode: The VDR gathers data for the indicated period. After the period elapses it sends a single report containing the data to the CMU using a STAT.indication message.

For both of these modes the VDR will gather data for the period indicated and then send the data to the CMU in a STAT.indication message. If the VDR receives a STAT.request message from the CMU during the data gathering period, then it will abort the data gathering activity (no STAT.indication is sent), and will begin gathering data anew for the mode indicated in the new STAT.request message.

Message Format

The message consists of one BOP file general format message block containing the following:

Octet	Parameters
1	EGFI
2	Primitive ID
3	Data field length MSB
4	Data field length LSB
5	Command
6-7	reporting period

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

Parameters

EGFI
$F2_h$

Primitive ID field
28_h

Data field length MSB
00_h

Data field length LSB
03_h

Command
00_h = disable periodic statistics reporting mode
01_h = enable periodic statistics reporting mode
02_h = change periodic reporting period
03_h = enable a single report for the duration indicated in the reporting period field

Reporting period MSB, LSB
1 to 1440 minutes, resolution minutes

Normal Response

The VDR responds within one second of receipt with a STAT.confirm, message.

Error response

In the event the VDR detects an error in the data contained in the message it sends a VDR_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid, reporting period greater than 1440 minutes or otherwise in error.

State

This message is processed in the PROTOCOL_SET substate of state ***CMD***.

New State

The resulting state is unchanged.

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

A11.5.16 Message STAT.confirm

The STAT.confirm message is sent by the VDR to indicate that an error free STAT.request message was received and is being processed. It is sent within one second of receipt of an error free STAT.request message.

Destination Code

The Destination Code should be set to 00_h

Message Format

The message consists of one BOP file general format message block containing the following:

Octet	Parameters
1	EGFI
2	Primitive ID
3	Data field length MSB
4	Data field length LSB
5	Command
6-7	Reporting period

Parameters

EGFI
$F2_h$

Primitive ID field
58_h

Data field length MSB
00_h

Data field length LSB
03_h

Command
00_h = disable statistics reporting mode
01_h = enable statistics reporting mode
02_h = change reporting period
03_h = enable a single report for the duration indicated in the reporting period field

Reporting period MSB, LSB
1 to 1440 minutes, resolution minutes

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

Normal Response

None.

Error response

In the event the CMU detects an error in the data contained in the message, it sends a CMU_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid, does not match request or otherwise in error.

State

This message is processed in the PROTOCOL_SET substate of state ***CMD***.

New State

The resulting state is unchanged.

A11.5.17 Message STAT.indication

The STAT.indication message is sent by the VDR to send statistics data to the CMU. If the STAT.request message commanded periodic data, then the data is sent at the periodic interval indicated. If the STAT.request message commanded a single message, then one STAT.indication message is sent.

Message Format

The message consists of one BOP file general format message block containing the following:

Octet	Parameters
1	EGFI
2	Primitive ID
3	Data field length MSB
4	Data field length LSB
5	Cumulative VHF channel Busy (Tcu), range 0 to 99 (00_h to 63_h).
6-8	Cumulative MAC delay (Tmac), 000000 to 999999 ms (0000_h to $0F423F_h$)
9-10	Number of downlink blocks received from surrounding aircraft (D3), 000 to 999 (0000_h to $03E7_h$)

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

Octet	Parameters
11-12	Number of incomplete downlink blocks received from surrounding aircraft (ID3), 000 to 999 (0000_h to $03E7_h$)
13-14	Number of downlink blocks received with bad BCS from surrounding aircraft (BD3), 000 to 999 (0000_h to $03E7_h$)
15	Number of uplink blocks addressed to aircraft with bad BCS (BU3), 00 to 99 (00_h to 63_h)
16	Number of incomplete uplink blocks addressed to aircraft (IU3), 00 to 99 (00_h to 63_h)
17-18	Number of uplink blocks addressed to other aircraft with bad BCS (BU4), 000 to 999 (0000_h to $03E7_h$)
19-20	Number of incomplete uplink blocks addressed to other aircraft (IU4), 000 to 999 (0000_h to $03E7_h$)
21	Number of Squitters received with bad BCS (BSQ2), 00 to 99 (00_h to 63_h)
22	Number of incomplete Squitters received (ISQ2), 00 to 99 (00_h to 63_h)

Parameters

EGFI
$F2_h$

Primitive ID field
59_h

Data field length MSB
00_h

Data field length LSB
12_h

Data
Variable, as described herein and in ARINC Specification 618, Section 5.10.2.

Normal Response

None.

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

Error response

In the event the CMU detects an error in the data contained in the message, it sends a CMU_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid, or otherwise in error.

State

This message is processed in the PROTOCOL_SET substate of state ***CMD***.

New State

The resulting state is unchanged.

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

Table A11-1 VDR - CMU Primitives

Note: All primitives are composed of Extended BOP files except as indicated.

Command/Query message	Primitive	Sender	Primitive ID	Type
Operational parameter request	PARAM.request	CMU	20_h	COMMAND
CMU data transfer request	UNITDATA.request	CMU	21_h	DATA
Address request	ADDR.request	CMU	22_h	COMMAND
CMU Error indication	CMU_ERROR.indication	CMU	23_h	COMMAND
Transmit buffer purge request	PURGE.request	CMU	25_h	COMMAND
Audit mode request	AUDIT.request	CMU	26_h	COMMAND
Statistics mode request	STAT.request	CMU	28_h	COMMAND
Parameter confirmation	PARAM.confirm	VDR	50_h	COMMAND
VDR data transfer indication	UNITDATA.indication	VDR	51_h	DATA
Address confirmation	ADDR.confirm	VDR	52_h	COMMAND
VDR Error indication	VDR_ERROR.indication	VDR	53_h	COMMAND
Signal quality indication	SQP.indication (Extended SOLO word)	VDR	"000"	N/A
CMU data transfer confirmation	UNITDATA.confirm	VDR	55_h	COMMAND
Audit mode confirmation	AUDIT.confirm	VDR	56_h	COMMAND
Audit data transfer indication	AUDITDATA.indication	VDR	57_h	DATA
Statistics mode confirmation	STAT.confirm	VDR	58_h	COMMAND
Statistics data transfer indication	STAT.indication	VDR	59_h	COMMAND

Table A11-2 Error Messages

Error Condition	Sender	Error code	Error data
Unspecified Error	CMU/VDR	00_h	Don't care
Unrecognized Primitive ID	CMU/VDR	01_h	Offending Primitive ID
BADDATA	CMU/VDR	02_h	Offending Primitive ID
Out of Sequence or Unexpected Primitive	***CMU/VDR***	***04_h***	***Offending Primitive ID***

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

Table A11-3 Generic Message Block Format

Field Name	Length
Start of Heading	1 char
Mode	1 char
Address	7 char
Technical Acknowledgment	1 char
Label	2 char
Uplink/Downlink Block Identifier	1 char
Start of Text	1 char
Text	220 char Max
Suffix	1 char
Block Check Sequence	16 bits
BCS Suffix Character	1 char

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

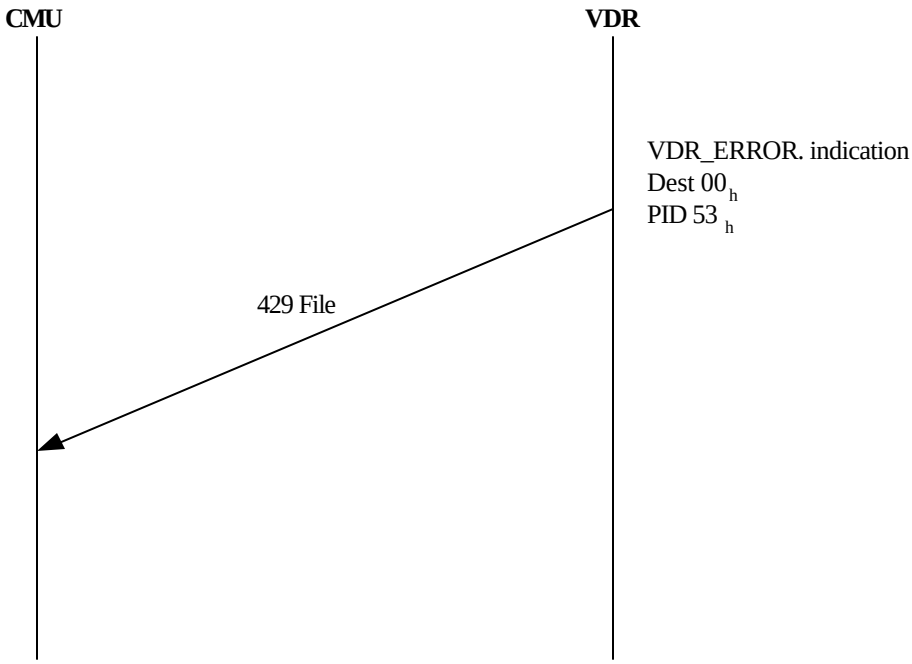


Figure A11-1 VDR Error Message

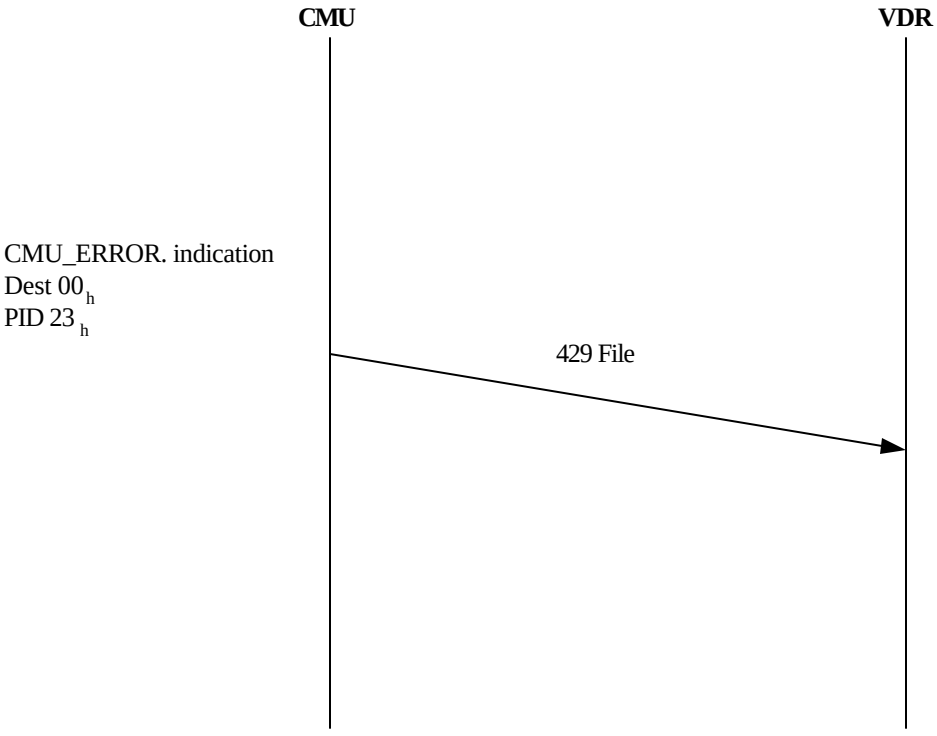
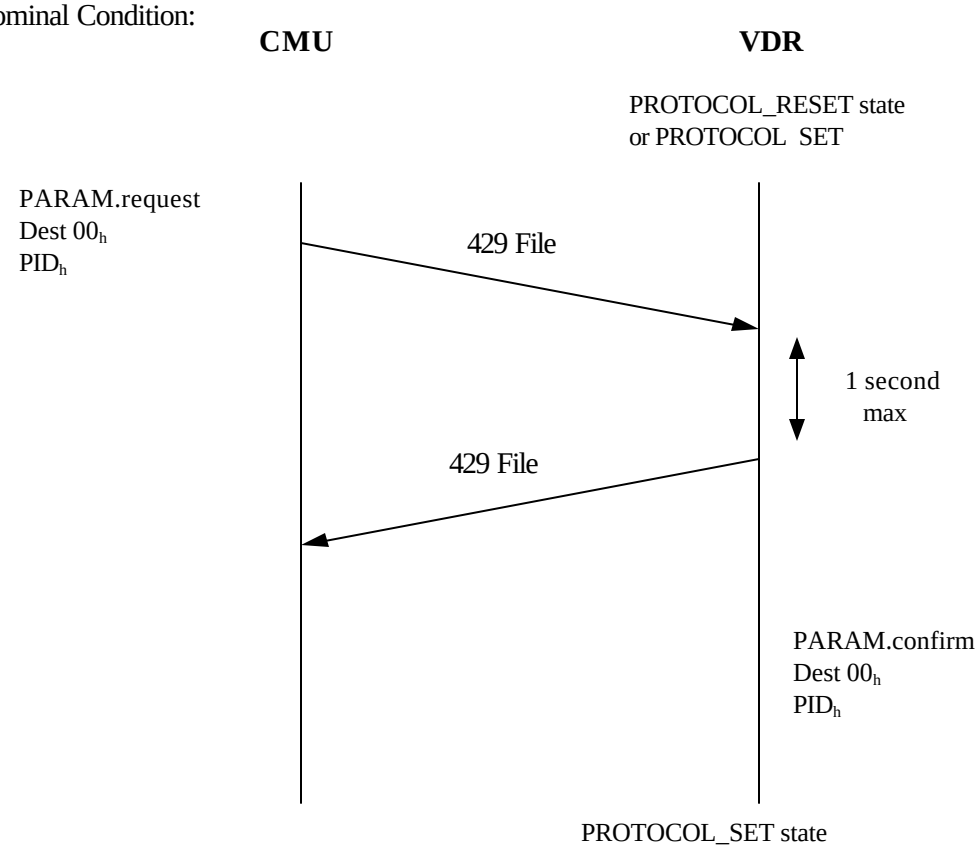


Figure A11-2 CMU Error Message

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

Nominal Condition:



Error Condition:

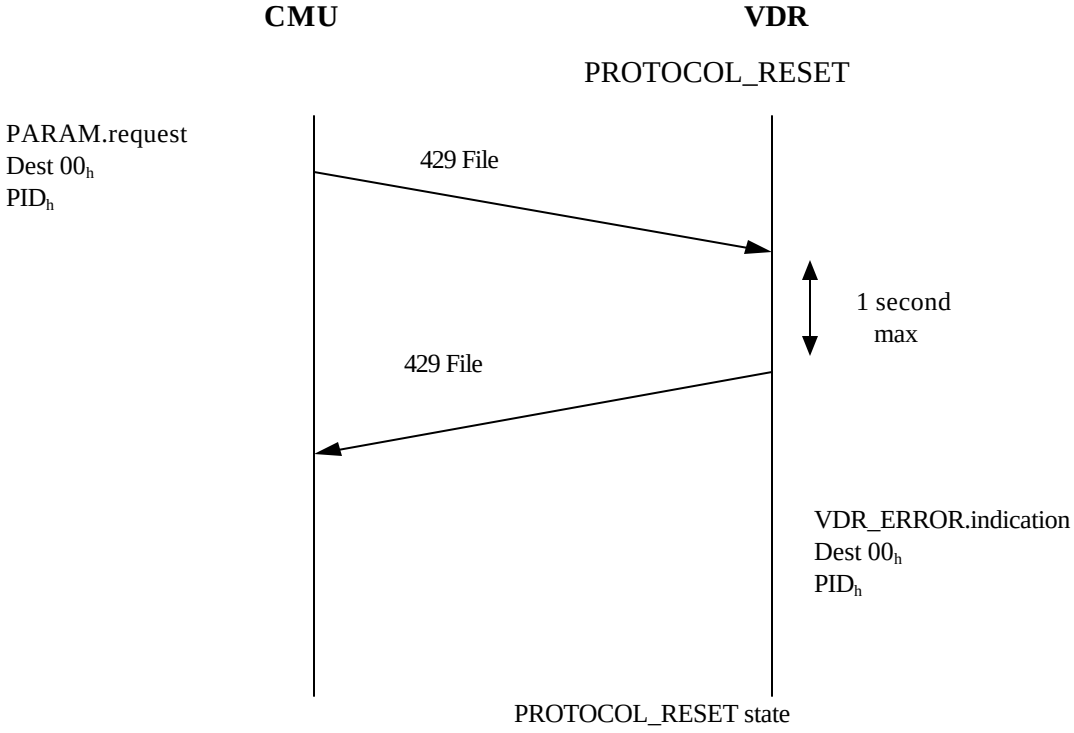


Figure A11-3 VDR Operating Parameter Data

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

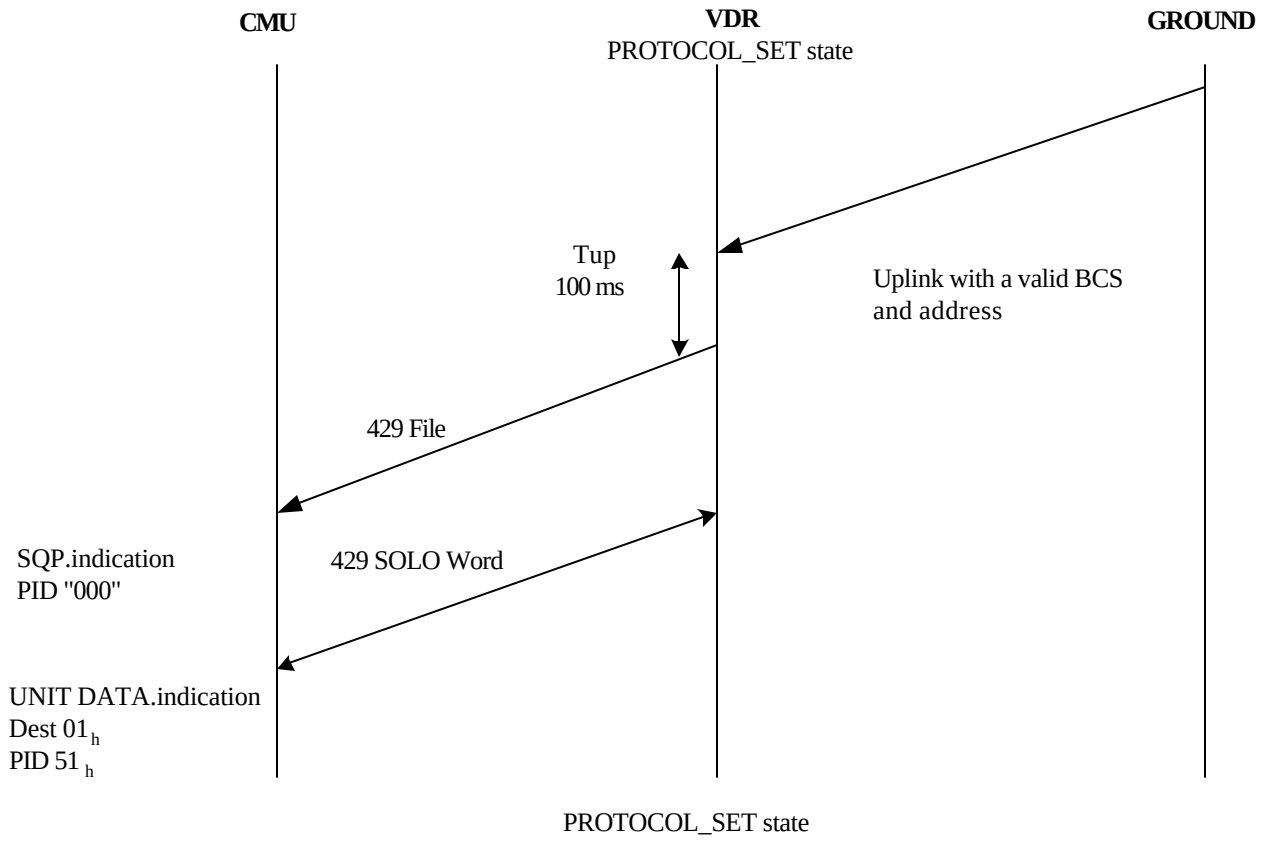


Figure A11-4 Uplink Process Reporting

Note: The UNITDATA.indication and SQP.indication should be sent in the order shown.

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

Nominal Condition :

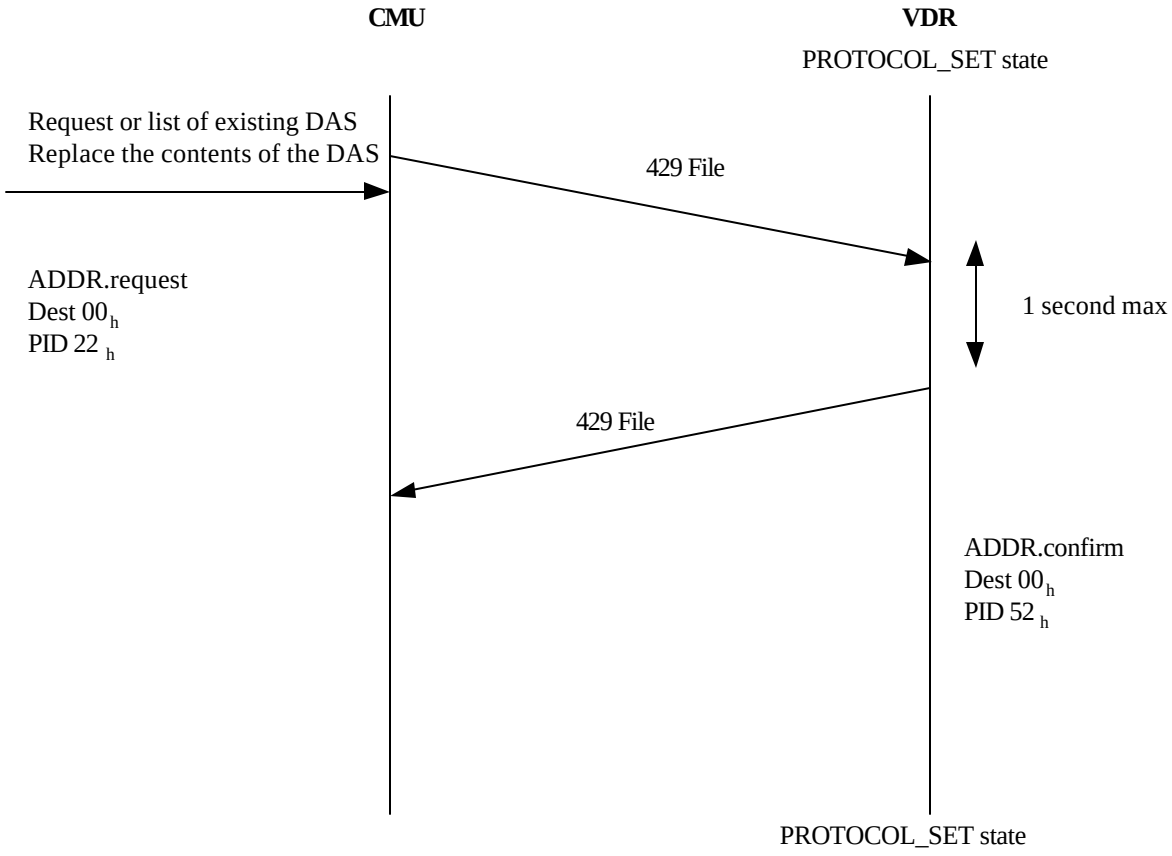


Figure A11-5 Address Request and Address Response

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

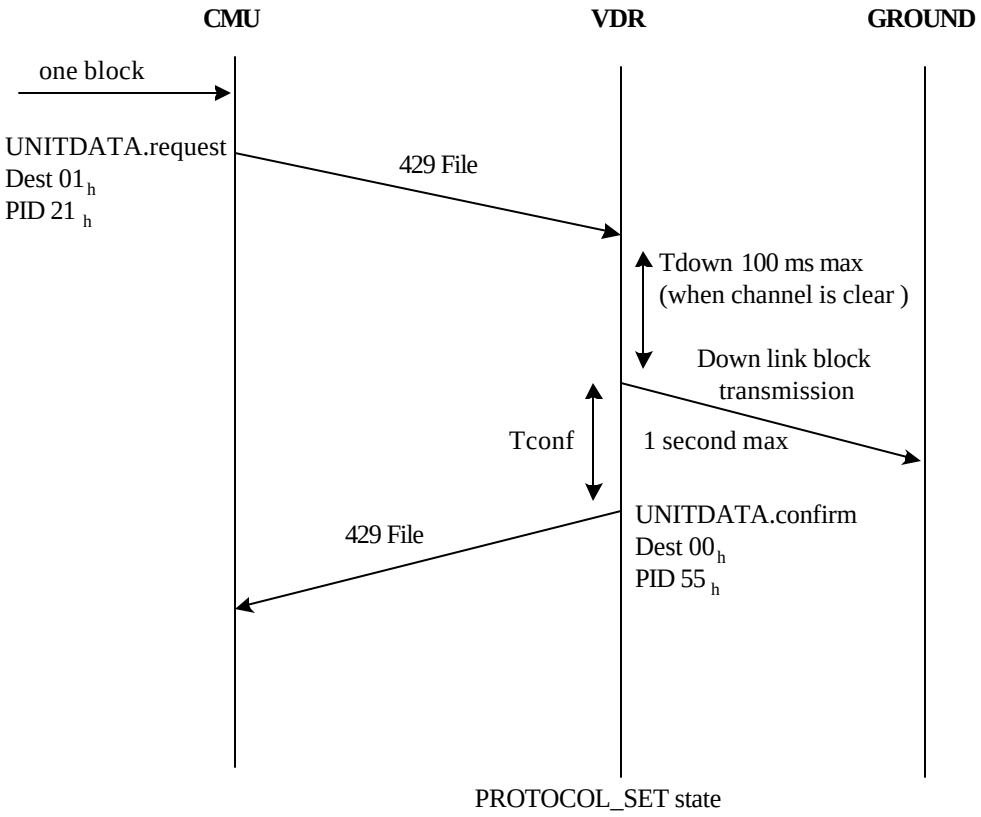


Figure A11-6 Downlink Message Handling

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

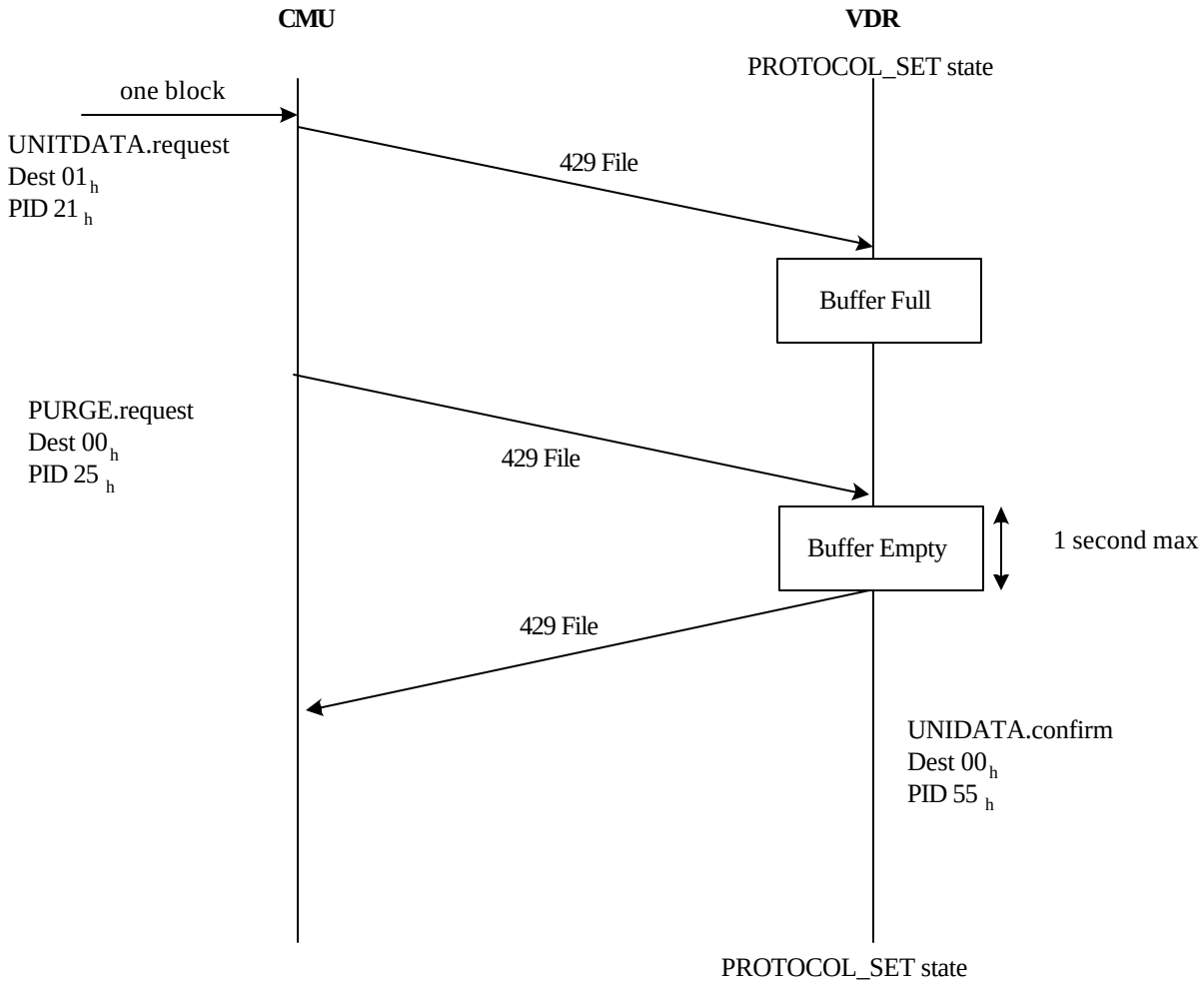


Figure A11-7 Purge Request With an Untransmitted Buffer (See Section A11.5.12)

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

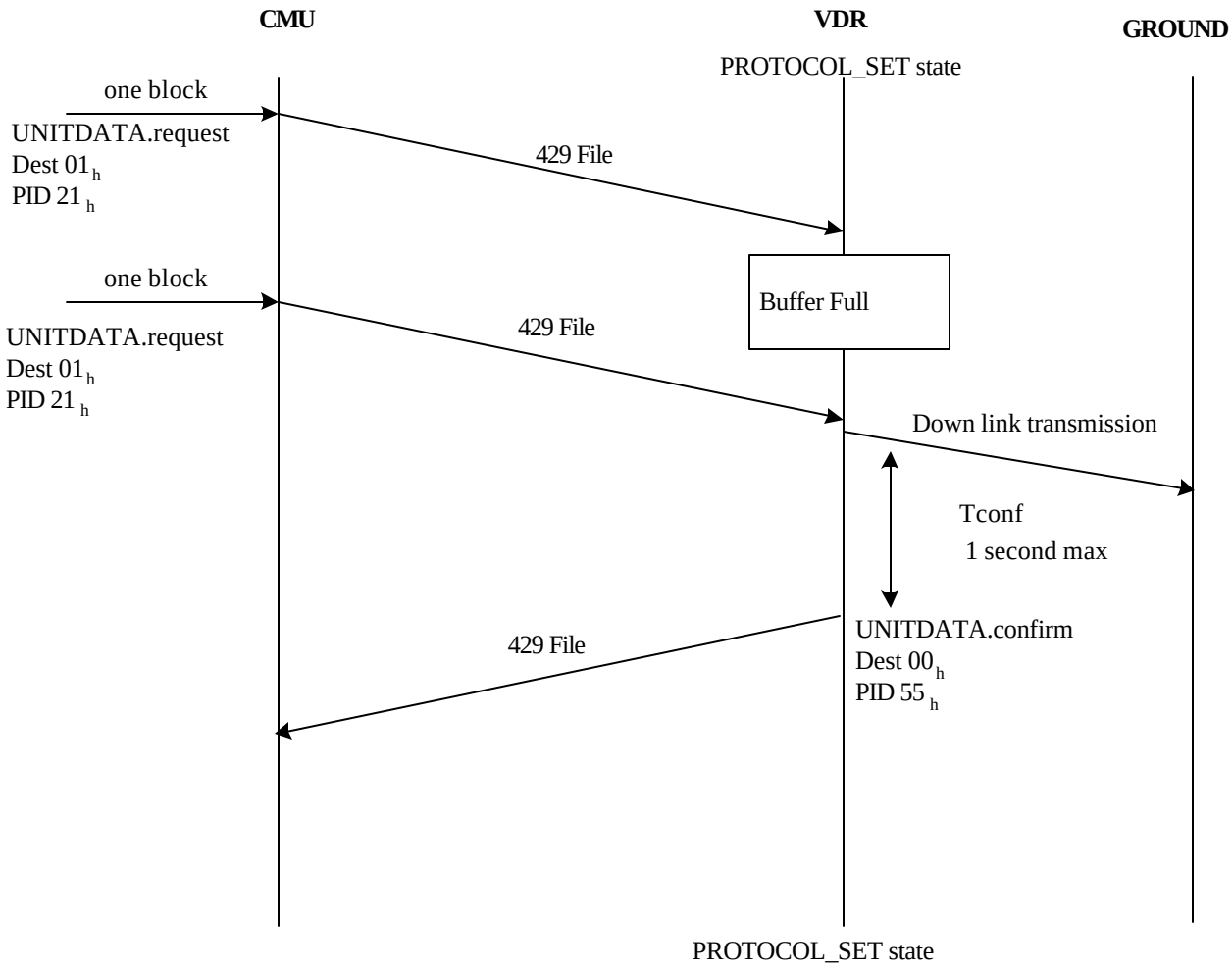


Figure A11-8 UNITDATA.request With a Full Buffer

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

Nominal condition:

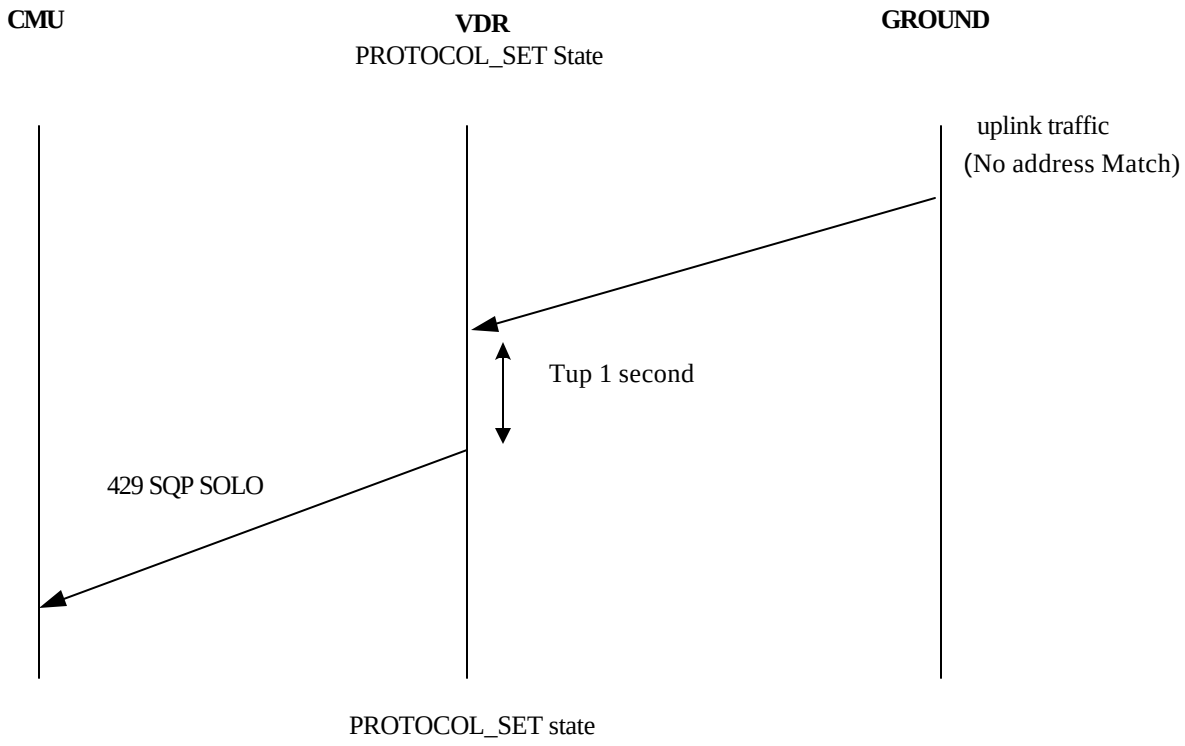


Figure A11-9 SQP Message Handling

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

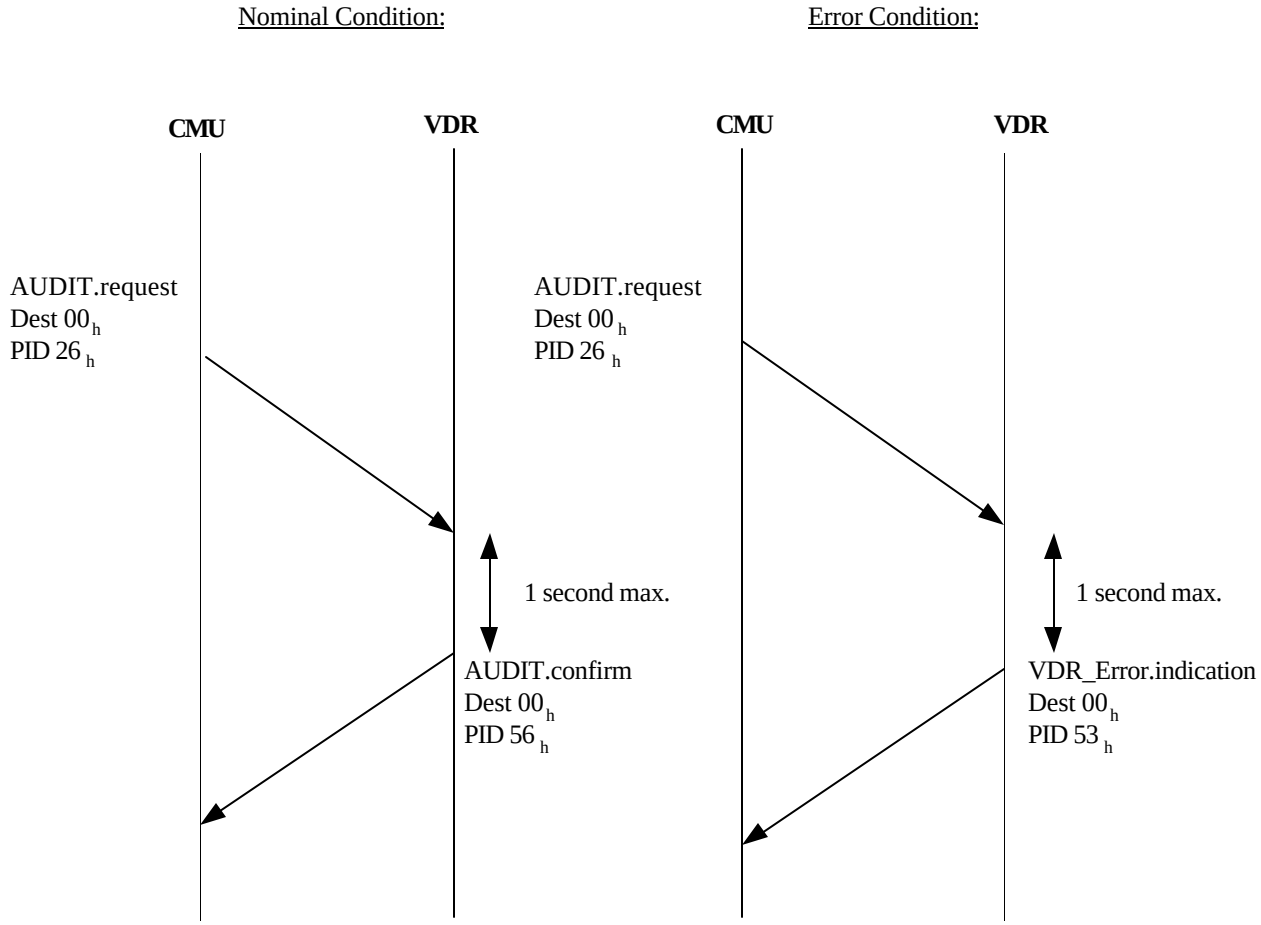


Figure A11-10 VDR AUDIT.request and AUDIT.confirm

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

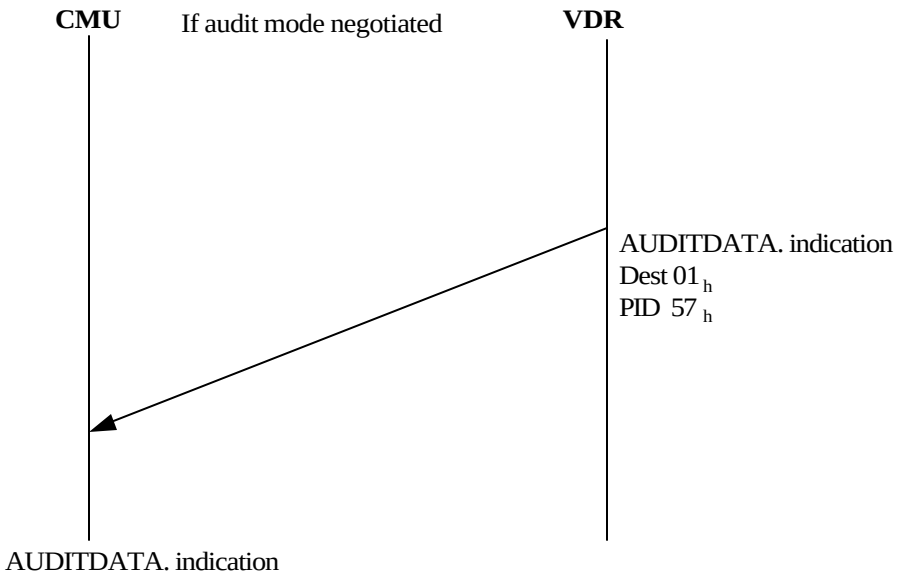


Figure A11-11 VDR.AUDITDATA.indication

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)

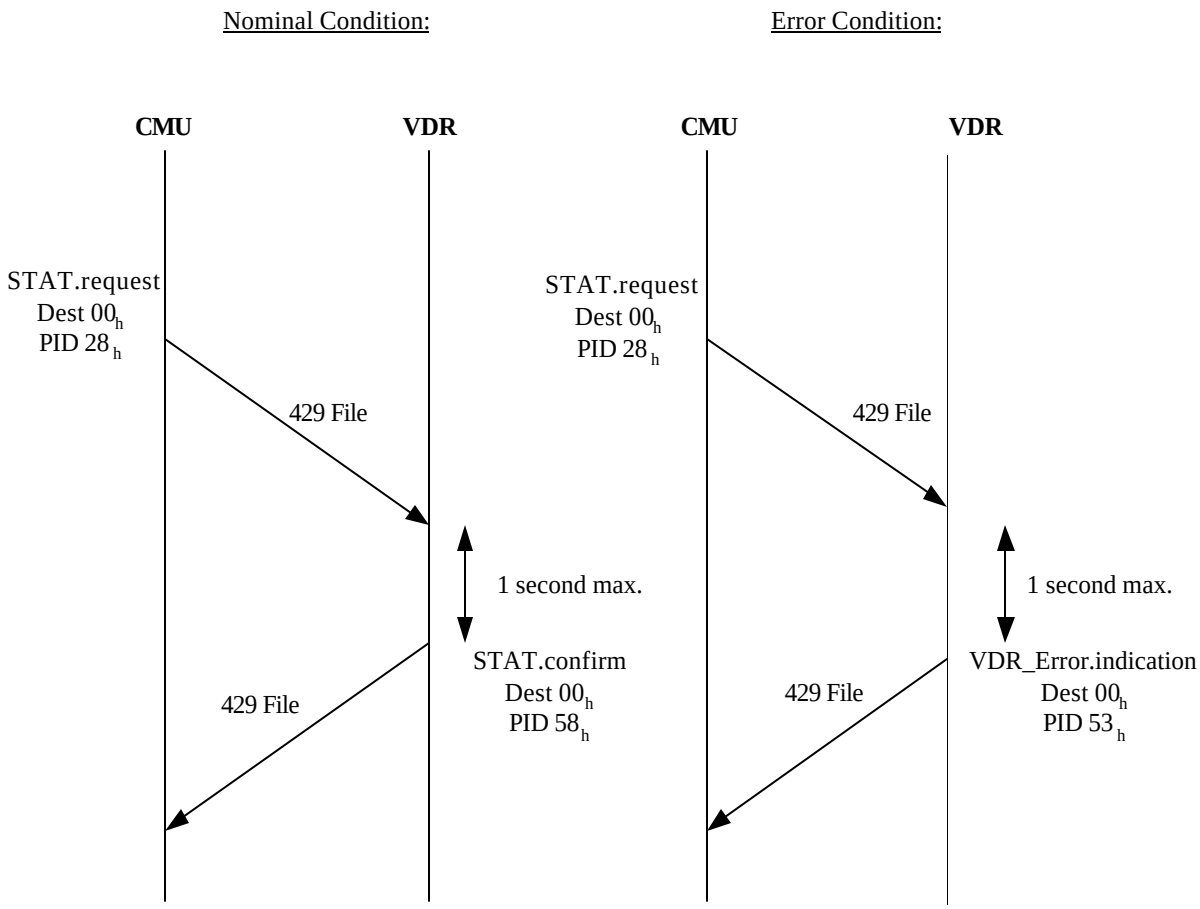
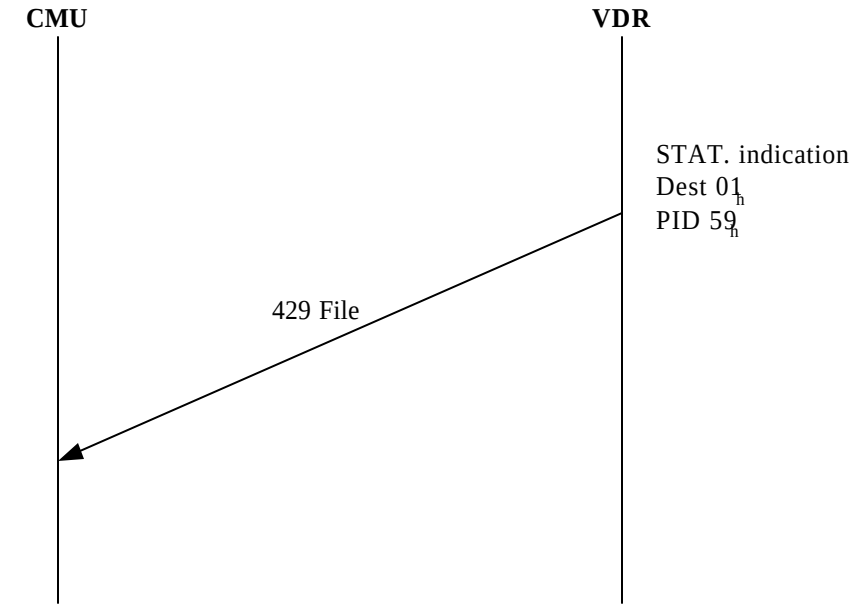


Figure A11-12 VDR STAT.request and STAT. confirm

ATTACHMENT 11 (cont'd)
ACARS INTERFACE PROTOCOL (ACARSIP)



STAT.indication

Figure ATT 13 - VDR STAT.indication

ATTACHMENT 12
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

A12.1 Purpose

This attachment to ARINC Characteristic 750 defines the VDL Mode 3 Simple Interface Protocol (V3SIP). V3SIP is a collection of messages, methods and procedures that can be implemented in a VDR and a CMU to enable the pair to function as an entity in a VDLM3 network that supports data link services. The associated Link Layer procedures and functions are shared, and are in common, with VDLM3 Basic and Enhanced Voice operations.

A12.2 Overview

The defining documents that describe the functions, methods and procedures to be implemented by an airborne entity performing VHF Digital Link (VDL) operations using Mode 3 are the ICAO VDL SARPs and its associated Manuals, the RTCA VDL MASPS (DO-224A) and the RTCA VDLM3 MOPS (RTCA DO-271A). See Appendix C herein for complete descriptions of these documents.

The CMU and the VDR operate together to implement the functionality defined by Section 6.5 of the VDL SARPs and Section 3.3.2 of the VDL MASPS. A functional partitioning can be imposed between the VDR and the CMU to implement the SARPs and MASPS protocol, as described in the RTCA VDLM3 MOPS. V3SIP defines a split in link layer functionality between the VDR and the CMU subsystems as well as the protocols and procedures necessary to support it.

The VDLM3 link layer is divided into three sub-layers:

a. A Media Access Control (MAC) sub-layer, which uses Time Division Multiple Access (TDMA) to support 3 or 4 channels (time slots) per 25 kHz frequency assignment. Each time slot is assigned to a group of users. In System Configurations that support VDLM3 Voice services only, the MAC sub-layer supports the transmission of Voice bursts and Management bursts on a selected time slot. In System Configurations that support simultaneous VDLM3 Voice and Data services, the MAC sub-layer supports the transmission of Voice bursts, Data bursts and Management bursts on two or more time slots. The MAC sub-layer resides in the VDR in its entirety.

b. A Data Link Service (DLS) sub-layer, which acts as a point-to-point addressed link between an aircraft and a ground station, and as a broadcast link from a ground station to aircraft members of the VDLM3 net. This sub-layer makes use of the MAC sub-layer services. The DLS sub-layer functionality is split between the CMU and VDR.

c. A Link Management Entity (LME) sub-layer, which establishes and maintains connections between aircraft and ground stations using MAC sub-layer services as well as DLS sub-layer services. This sub-layer is also split between the CMU and VDR.

COMMENTARY

The DLS sub-layer is used only for Data communications, as Voice communications do not require a CMU.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

The VDLM3 functional partitioning between VDR and CMU is illustrated in the Figure A12-1 and defined in detail in Table A12-1. The messages (V3SIP primitives) exchanged between VDR and CMU to support the VDLM3 functional partitioning are listed in Table A12-2.

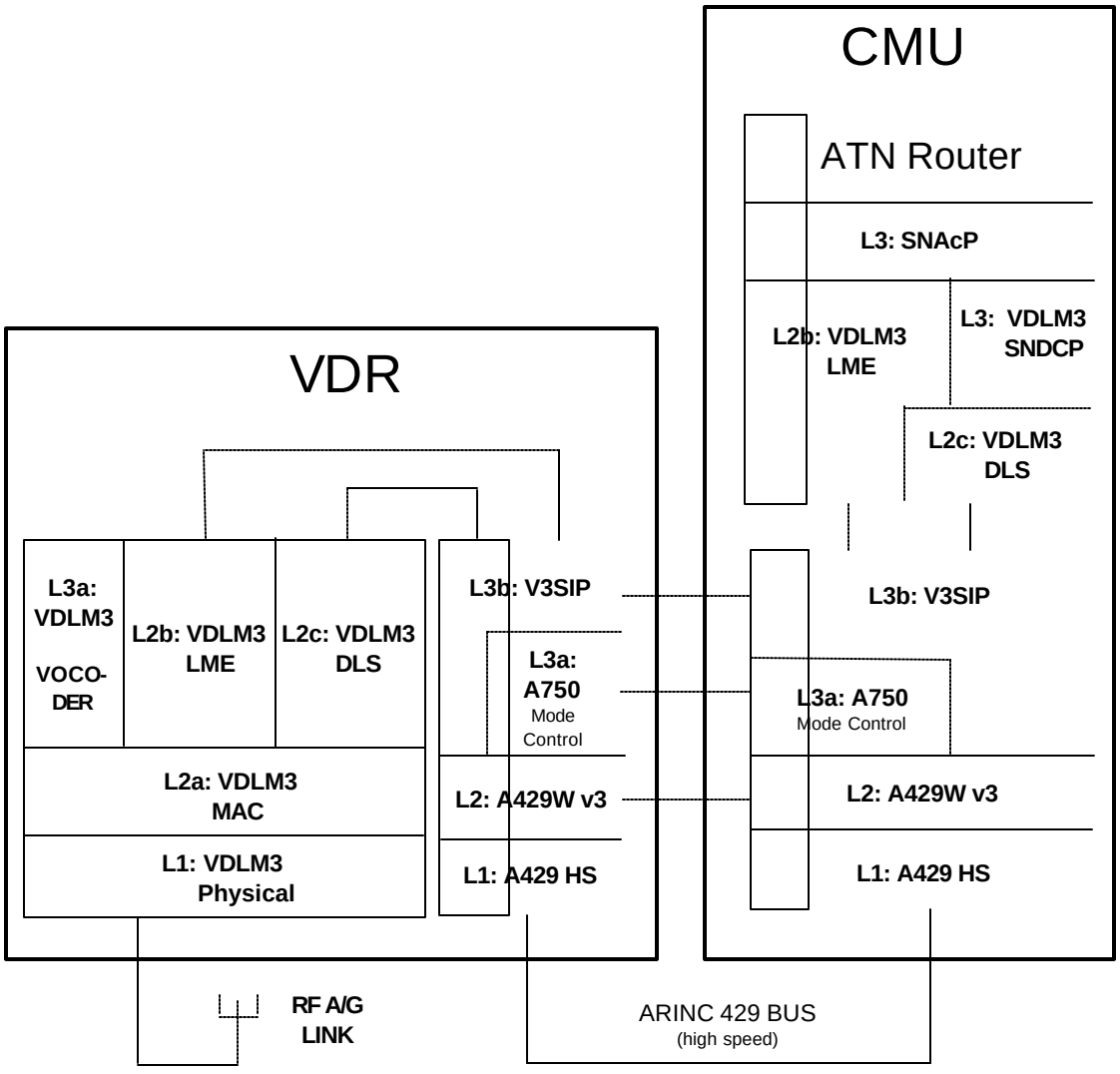


Figure A12-1 – VDLM3 Functional Partitioning

A12.3 V3SIP Protocols and Procedures

A12.3.1 Overview

The V3SIP CMU/VDR Interface Protocol consists of a set of messages (primitives) embedded in the payload fields of ARINC 429 Bit Oriented Protocol (BOP) "files" and "SOLO words". The generic

formats of these "files" and "SOLO words" are defined in Section 5.1.3.1 (Extended BOP file format) and Section 5.1.3.2 (ARINC 429 SOLO words with extended ID – Extended SOLO words). As defined in Section 5.1.2.3, the BOP file primitives used are of types COMMAND or DATA. The format of the V3SIP-specific Extended SOLO word is defined in Section A12.3.6.

A12.3.1.1 V3SIP Initialization

Before the VDR and CMU can begin exchanging V3SIP messages, the V3SIP Initialization procedure defined in Section 5.2.2 must be completed and the CMU/VDR Interface must be operating in the PROTOCOL_RESET state. Prior to that time, exchange of V3SIP messages is inhibited.

A12.3.1.2 Net Entry

To support VDLM3 Basic Voice service, the VDR needs only to complete the net initialization procedure defined in the VDL SARPs and RTCA VDL MASPS. In order to reach an operating state that supports the transmission and reception of VDLM3 Enhanced Voice Service and Data Service, the VDR must have completed the VDLM3 Net Initialization and Net Entry procedures defined in the VDL MASPS and SARPs, the VDLM3 ground station System Configuration must be one that supports simultaneous VDLM3 Voice and Data services, and the CMU/VDR Interface protocol must be in the DLS_ON state.

The VDLM3 Net Entry procedure relies on services provided by the MAC sub-layer and is controlled by the LME functionality in the VDR. The VDLM3 Net Entry procedure is totally independent of the CMU. As part of the Net Entry process, the VDR is assigned a unique Aircraft ID by the ground station for use in the MAC Management (M) and V/D(voice) bursts to support Enhanced Voice operation. The ground station maintains an association between the Aircraft ID and the aircraft's ICAO Address.

The VDR uses the VDLM3 Data Services Status field in the ARINC 429 Label 270 broadcast words to inform the CMU about the status and progress of the Net Entry procedures (see Table A8-8 in Attachment 8). When the VDR has completed Net Entry to a VDLM3 net associated with a system configuration that also supports data services, it sets the VDLM3 Data Services field of Label 270 to "Entered Net -- Data Services Available".

When the VDLM3 Data Services Status field of the Label 270 words becomes either "Entered Net – Data Services Not Available" or "Entered Net -- Data Services Available", the CMU may send a PARAM.request to the VDR to request the relevant Net parameters. The VDR responds with a PARAM.confirm and the CMU/VDR Interface transitions to the PROTOCOL_SET state.

A12.3.1.3 Data Link Function Enable

The CMU is responsible for verifying that no other VDR installed on the same aircraft is operating on the same VDLM3 channel, for turning ON the data link functionality (send DLS_ON.request) if there is no conflict, and for inhibiting the data link functionality (send DLS_OFF.request) if

another VDR is already using the same data slot. The CMU uses the VDLM3 channel configuration parameters contained in the PARAM.confirm message to decide whether to enable data operation with each VDR.

Once data link operation is enabled by the CMU (DLS_ON.request received and DLS_ON.confirm sent by the VDR), the CMU/VDR Interface enters the DLS_ON state, and the VDR begins processing received VDLM3 data bursts, delivering uplinks to the CMU (UNITDATA.indications) and accepting data (UNITDATA.requests) from the CMU for downlink transmission. While this process is on-going, the ability of the VDR to provide VDLM3 Voice services on the voice slot is not affected.

A12.3.1.4 Link Parameter Negotiation

The CMU is responsible for negotiating link parameters and network protocol support with the VDLM3 ground station using CTRL_CMD and CTRL_RSP Frames. When the CMU has completed the link negotiation it sends a DLS_CONNECTED.indication to the VDR if the negotiation has been successful or a DLS_DISCONNECTED.indication if the negotiation was not successful. The DLS_CONNECTED.indication contains a flag that tells the VDR whether it should continue using the default MAC and LME parameters or else to use the included negotiated parameter values.

The VDR uses the reception of the DLS_CONNECTED.indication to notify the RTP via the ARINC 429 Label 051 words that simultaneous Enhanced Voice and Data services are operational.

A12.3.1.5 Data Link Reception

A received VDLM3 data burst contains 62 octets of user data that may comprise one or more DLS Frames or a portion of a DLS Frame. The MAC sub-layer is responsible for stripping the MAC header and re-assembling one or more bursts into a Frame Group and forwarding a complete uplink Frame Group to the DLS sub-layer in the VDR for address/FCS screening and acknowledgement.

The DLS sub-layer separates the Frames in a received uplink Frame Group into two sub-groups for address/FCS screening. One sub-group contains all DLS Frames requiring acknowledgement; i.e., discretely-addressed INFO Frames and CTRL_RSP Frames. The second sub-group contains all DLS Frames that do not require acknowledgement; i.e., broadcast INFO Frames, CTRL_CMD Frames and ACK Frames. Each frame in each sub-group is checked to make sure it (1) contains an Aircraft Address that matches either the aircraft's 24-bit ICAO Address (see A12.4.9) or the Broadcast Address (all 1's), and (2) that the frame passes the FCS check.

Frames in both subgroups that fail one or both screening criteria are discarded.

In the sub-group containing frames requiring acknowledgement, if any frames fail the screening criteria, then the entire sub-group is discarded. If all the frames in this sub-group pass the address/FCS screening, then an M-burst ACK message is sent to the ground in the next MAC cycle.

All remaining undiscarded uplink frames from both sub-groups, including DLS ACK Frames, are sent to the CMU in a single UNITDATA.indication. The FCS of each frame contained in the UNITDATA.indication is stripped but the Aircraft Address field remains. Thus, the CMU does not have to repeat the FCS screening and may use the Aircraft Address field for checking. The CMU is responsible for detecting duplicate frames and discarding them and for processing DLS ACK frames to cancel any active downlink retransmision T1 timers.

A12.3.1.6 Data Link Transmission

The CMU is responsible for formatting each downlink DLS Frame, queuing, prioritizing and sending a downlink Frame Group to the VDR in a single UNITDATA.request. In addition to the Frame Group, the UNITDATA.request from the CMU should contain the sequence number for that Frame Group, the priority of the highest priority frame in the group, and whether the Frame Group contains any frames requiring acknowledgement (INFO Frames or CTRL_RSP Frames). The VDR uses the sequence number to confirm transmission or discard of the Frame Group. The VDR uses the priority and acknowledgment parameters in the formatting of the downlink MAC data bursts.

If the Frame Group contains any frames requiring acknowledgement, the CMU must not send another Frame Group until the ground has acknowledged reception of the Frame Group (DLS ACK received by CMU) or the re-transmission timer T1 has expired. Otherwise, if the Frame Group does not contain any frames requiring acknowledgement, the CMU may send another Frame Group (UNITDATA.request) as soon as transmission of the unacknowledged Frame Group has been completed.

The VDR sends a UNITDATA.confirm when it has completed transmitting a Frame Group, at which time the CMU starts its T1 timer if the Frame Group contains frames requiring acknowledgement. The UNITDATA.confirm contains the sequence number associated with the transmitted Frame Group and a flag indicating "transmission completed".

If a Frame Group accepted by the VDR for transmission contains more than 62 octets, the MAC sub-layer segments it into as many as 15 segments for transmission in multiple bursts.

A12.3.1.7 Priority Queue Management

Although the CMU may not send another Frame Group until transmission of the previous Frame Group has been completed, if the CMU has a higher priority Frame that it wants to send, the CMU can issue a PURGE.request. If transmission of the previous Frame Group is in progress, the VDR ignores the PURGE.request. If the VDR receives a PURGE.request prior to start of transmission of a Frame Group, the VDR discards the Frame Group and sends a UNITDATA.confirm to the CMU with the flag set to "frame group discarded".

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

A12.3.1.8 Recovery Procedures

The VDLM3 ground system enters a recovery process when it loses track of the aircraft entries in its net. The VDLM3 ground station will then broadcast a VDLM3 M-burst Recovery message informing all aircraft to go into recovery mode. The VDR sends a RECOVERY.indication to the CMU as soon as it determines that the ground station is in a recovery process. The RECOVERY.indication includes the number of downlink data segments pending transmission by the VDR, so the CMU can include its information in the Expedited Recovery XID. The CMU responds to the VDR with a RECOVERY.request message which includes a CTRL_RSP Frame containing the Network Initialization XID parameter and Expedited Recovery XID parameter. The VDR holds the CTRL_RSP Frame until an uplink M-burst Recovery message granting a slot reservation to the aircraft is received. The VDR responds to the "slot reservation grant" with the transmission of the CTRL_RSP Frame and sends a RECOVERY.confirm to the CMU. While the recovery process is in progress the CMU should halt all downlink DLS Frame transmissions until it receives a CTRL_CMD_LPM Frame containing a Connection Check XID parameter or it receives a LEFT_NET.indication from the VDR. The VDR should discard any UNITDATA.requests received from the CMU during this time and respond with a UNITDATA.confirm indicating the discard.

A12.3.1.9 Link Parameter Modification

Occasionally the VDLM3 ground station may command the CMU to renegotiate some of the link parameters after a link has been already negotiated. If the re-negotiation is successful and the new parameters negotiated include MAC sub-layer parameters, the CMU sends a DLS_CONNECTED.indication to the VDR with the flag set to indicate that new parameters are being provided. If the renegotiation is not acceptable to the CMU, the CMU sends a DLS_DISCONNECTED.indication to the VDR to indicate the termination of the data link. The VDR's ability to provide Enhanced Voice services is not affected. The DLS_CONNECTED.indication and DLS_DISCONNECTED.indication are used by the VDR only to determine how to set the Service Level Indication field in the Label 055 word sent to the RTP.

A12.3.1.10 Net Release

The VDR can leave the net for a variety of reasons; e.g., on command by the VDLM3 ground station (reception of Terminate Net M burst), by tuning command to change channel from the RTP, or by losing contact with the ground system. In all cases the VDR should send a message to the CMU (via LEFT_NET.indication), notifying it of the VDR leaving the net.

A12.3.2 ARINC 429 Interface Definition

The V3SIP should be implemented using only the ARINC 429 Williamsburg Version 3 bit oriented protocol. Williamsburg Version 3 Command Frames should be used for all file transfers.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

A12.3.3 BOP File Transfer GFI Code

The GFI code (contained in the FDU's Start of File (SOF) word) associated with all BOP data files should be set to "F_h", indicating an extended GFI.

A12.3.4 BOP File Transfer Command Type Code

The Command Type Code (contained in bits 23 - 24) of the Command Frame SOF word, should be set according to the following values:

Command primitives 0_h
Data transfer primitives 1_h

Only the UNITDATA.request, RECOVERY.request and UNITDATA.indication primitives contain downlinks or uplinks and thus have a Command type code of 1_h. All remaining primitives are command primitives and as such have a Command type code of 0_h.

A12.3.5 General File Format

The format of all BOP file transfers conforms to a common format for data transfer and is shown in Section 5.1.3.1, BOP File Transfer Extended GFI Code.

A12.3.6 V3SIP Extended SOLO Word Format

The general Extended SOLO word definition in section 5.1.3.2 leaves bits 9 through 20 undefined. These bits were left as an unspecified data field to be defined in a specific CMU/VDR Interface Protocol. The V3SIP definition provides sixteen Primitive IDs and an 8-bit data field.

The V3SIP format for Extended SOLO words is as follows:

Bit	*Definition*	*Comment*
32	*Parity*	*Odd parity*
31-29	*"101_b"*	*(indicates SOLO)*
28-25	*"F_h"*	*(indicates Extended SOLO Word)*
24-21	*"3_h"*	*(indicates V3SIP CMU/VDR Interface Protocol)*
20-17	*PID*	*Primitive ID, one of sixteen*
16-09	*Data*	*8-bit data field*
08-01	*SAL*	

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

A12.4 Procedures

A12.4.1 Initialization and V3SIP States

Section 5 defines the CMU to VDR interface as providing support for multiple interface protocols. It defines the initialization procedure to be performed in order to bring the interface to a functional state upon reset or power up. As part of initialization, the VDR determines the status of any CMU on the ARINC 429 bus and negotiates the Williamsburg version to be used. As defined in the procedures of Section 3.3 and per Table 3-2, the VDR determines the correct operating mode. The procedures in Section 5.2 define CMU/VDR interface initialization.

Three substates of the CMD state are defined in Section 5: PROTOCOL_NULL, PROTOCOL_RESET, and PROTOCOL_SET. The V3SIP interface protocol defines one additional substate, DLS_ON, of the CMD state. These four substates of the CMD state are illustrated in Figure A12-2. The transition events are described below the figure.

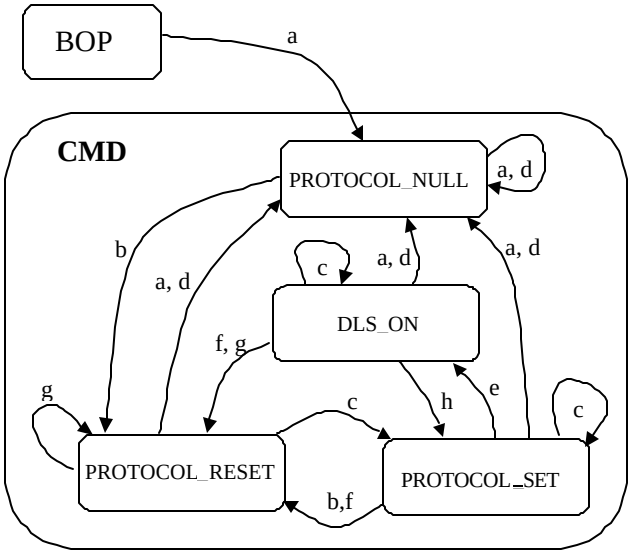


Figure A12-2. CMD Nested State Diagram

a. MODE_SET.request received, MODE_SET.confirm sent
b. PR_SET(V3SIP).request received, PR_SET(V3SIP).confirm sent
c. PARAM.request received, PARAM.confirm sent (Entered Net - Data Services Available, Entered Net - Data Services Not Available)
d. PR_SET.request received, PR_SET.confirm sent (error or unsupported protocol)
e. DLS_ON.request received, DLS_ON.confirm sent. (Success octet = Enabled)
f. LEFT_NET.indication sent
g. PARAM.request received, PARAM.confirm sent (VDLM3 System Configuration parameter = FFh)
h. DLS_OFF.request received, DLS_OFF.confirm sent.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

A12.4.1.1 PROTOCOL_NULL State

The PROTOCOL_NULL state is the initial substate of the CMD state. It should be entered whenever the VDR has received a MODE_SET.request from the CMU and has responded with a MODE_SET.confirm. This is a transitional state in which the VDR communicates with the CMU during the protocol negotiation process using command primitives defined in Section 5.

The PROTOCOL_NULL state has no requirement on the VDR's net entry status. It should be entered regardless of whether the VDR has entered the net.

Contents of VDR's transmitted Label 270 status word:

Protocol Status Bit (14) = "0"
Download Request Bit (11) = "0"
DLS Enable Bit (12) = "0"

A12.4.1.2 PROTOCOL_RESET

The PROTOCOL_RESET state should be entered when VDR responds to a PR_SET.request with a PR_SET.confirm indicating the selection of the V3SIP Interface Protocol.

Contents of VDR's transmitted Label 270 status word:

Protocol Status Bit (14) = "1"
Download Request Bit (11) = "1"
DLS Enable Bit (12) = "0"

A12.4.1.3 PROTOCOL_SET

The PROTOCOL_SET state is entered when the VDR has sent a PARAM.confirm in response to a PARAM.request received from the CMU while the VDR is Logged-in to VDLM3 net. The PARAM.confirm contains several data elements, including the VDLM3 system configuration, the operating frequency and channel, and other VDLM3 net-specific operational parameters needed to determine whether VDLM3 data operation is supported by the VDLM3 ground station.

Entry to the PROTOCOL_SET state requires that the CMU send the PARAM.request only when Label 270 broadcast by the VDR indicates that the VDR has entered a VDLM3 Net; i.e., VDLM3 Data Service Status state set to either "Entered Net – Data Services Available" or "Entered Net – Data Services Not Available".

If the VDR receives a PARAM.request after it has entered the net, it should respond with a PARAM.confirm whose parameter settings contain the values active for the entered net, and the CMU/VDR Interface protocol should transition to the PROTOCOL_SET state.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

If the VDR receives a PARAM.request before it has entered the net, it should respond with a PARAM.confirm whose VDLM3 System Configuration parameter is set to FFh, and should remain in thePROTOCOL_RESET state. A setting of FFh for this parameter is an indication that the remaining network parameters in the PARAM.confirm message are invalid or are irrelevant.

If the VDR leaves the net (see section A12.4.13, Net Release), then it should send a LEFT_NET.indication to the CMU and the CMU/VDR Interface protocol should transition to the PROTOCOL_RESET state.

Contents of VDR's transmitted Label 270 status word:

Protocol Status Bit (14) = "1"
Download Request Bit (11) = "0"
DLS Enable Bit (12) = "0"

A12.4.1.4 DLS_ON

The DLS_ON state is entered when the VDR sends a DLS_ON.confirm with the Success octet set to "Enabled" (Section A12.5.13) in response to the DLS_ON.request from the CMU. The CMU sends the DLS_ON.request after determining, from the PARAM.confirm containing the VDLM3 Net Channel and System Configuration provided by the VDR(s), that no other VDR is already providing data link services on the same VDLM3 data channel. Transmission of downlink data and reception of uplink data via VDLM3 may then begin. The VDR should send a DLS_ON.confirm to the CMU with the Success octet set to "Enabled" only if the ground station supports data link services. Otherwise, the VDR should send a DLS_ON.confirm to the CMU with the Success octet set to "Disabled", and the CMU/VDR interface should stay in the PROTOCOL_SET state.

If the VDR leaves the net (see Section A12.4.13), then it should send a LEFT_NET.indication to the CMU and the CMU/VDR Interface protocol should transition to PROTOCOL_RESET state.

Contents of VDR's transmitted Label 270 status word:

Protocol Status Bit (14) = "1"
Download Request Bit (11) = "0"
DLS Enable Bit (12) = "1"

A12.4.2 VDR Periodic Reporting

The VDR periodically sends broadcast words to the CMU to convey status information as defined in Section 5.5.

A12.4.3 CMU Periodic Reporting

The CMU periodically sends broadcast words to the VDR to convey status information as defined in Section 5.5.

A12.4.4 VDR Error Message

If the VDR experiences a protocol error during the exchange of V3SIP messages with the CMU, it should send a VDR_ERROR.indication message. This message may be used to indicate that the VDR has received a message out of sequence, that the message is unrecognized, or that the message format is in error.

A12.4.5 CMU Error Message

If the CMU experiences a protocol error during the exchange of V3SIP messages with the VDR, it should send a CMU_ERROR.indication message. This message may be used to indicate that the CMU has received a message out of sequence, that the message is unrecognized, or that the message format is in error.

A12.4.6 Net Initialization and Net Entry

The Net Entry event occurs as the result of a successful air/ground Net Initialization and Net Entry procedure performed by the VDR. The Net Initialization and Net Entry procedure should be initiated by the LME function within the VDR under a number of conditions defined in RTCA DO-224A. The Net Initialization and Net Entry procedure should be performed independently of the state of the CMU/VDR Interface protocol. When Net Initialization and Net Entry have been completed, data link communications may occur only if the entered net is configured to support data link operations and the CMU/VDR interface protocol has been initialized as specified in Section A12.4.1.

In order to support the initialization of the CMU/VDR interface protocol, the VDR should broadcast the status of the Net Initialization and Net Entry procedure to the CMU in the Data Services Status field of Label 270 (see Table A8-8) as follows. If the VDR is not tuned to a VDLM3 channel or cannot determine what services are supported on the VDLM3 channel then it should set this field to "Not Entered Net – Services Unknown". If the VDR has not entered the net but can detect that data services are supported by the net, then it should set this field to "Not Entered Net – Data Services Available. If the VDR has entered the net but can detect that data services are not supported by the net then it should set this field to "Entered Net – Data Services Not Available". If the VDR has entered the net and can detect that data services are available then it should set this field to "Entered Net – Data Services Available".

A12.4.7 VDR Operating Parameter Data

The PARAM.request message is used by the CMU to request VDLM3 net entry parameters, including operating VDLM3 channel and VDLM3 System Configuration, aircraft Local ID and other operating parameters currently in use by VDR such as MAC timers and counters.

If the VDR receives a PARAM.request message from the active CMU, it should transmit a PARAM.confirm to the CMU within 1 second of the reception. If the CMU/VDR interface protocol

state was PROTOCOL_RESET at the time the PARAM.confirm is sent, and if the VDR was Logged-in, then the VDR's CMU/VDR interface protocol state should transition to the PROTOCOL_SET state. Otherwise, if the CMU/VDR interface protocol state was PROTOCOL_SET or DLS_ON, the protocol state should stay the same.

A12.4.8 Data Transfer Enable and Disable

If the VDR receives a DLS_ON.request from the CMU while it is in the PROTOCOL_SET sub-state, it should respond with a DLS_ON.confirm within one second.

If the VDR is logged on to a data-capable net when a DSL_ON.request is received, then it should set the Data Enabled field in the DLS_ON.confirm to "1h", the CMU/VDR interface protocol should transition to the DLS_ON substate, and the VDR should enable downlink data (UNITDATA.request) handling and uplink data screening, acknowledgement and delivery (UNITDATA.indication).

If the VDR is not logged on to a data-capable network, then it should set the Data Enabled field in the DLS_ON.confirm to "0h", the CMU/VDR interface protocol should remain in the PROTOCOL_SET substate.

If the VDR receives a DLS_OFF.request from the CMU while the CMU/VDR interface is in the DLS_ON substate, it should respond with a DLS_OFF.confirm within one second and the CMU/VDR interface protocol should transition to the PROTOCOL_SET substate, and the VDR should disable downlink data (UNITDATA.request) handling and uplink data screening and delivery (UNITDATA.indication).

A12.4.9 Address Request

The VDLM3 air/ground net entry process requires that the VDR include the aircraft's ICAO Address in the Net Entry Request messages. The uplink DLS Frame processing performed by the VDR also requires use of the aircraft ICAO address and Broadcast Address to screen uplinked DLS frames prior to delivery to the CMU. However, as the VDR must be able to perform the net entry process in installations where a CMU is not installed, the VDR should get the ICAO Address from one of two ARINC 429 inputs (see Section 8.3) wired to Mode S transponders 1 and 2.

The CMU can request a copy of the ICAO Address and Broadcast Address used by the VDR by sending an ADDR.request message.

A12.4.10 Address Response

The VDR sends the CMU an ADDR.confirm message containing the ICAO and Broadcast Addresses it is using in response to an ADDR.request message from the CMU.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

A12.4.11 Downlink Message Handling

To send a message to the ground, the CMU should send the VDR a UNITDATA.request message. The message may contain one or more DLS Frames (INFO, CTRL_CMD and/or CTRL_RSP); i.e., a Frame Group of up to 930 octets. Prior to transmission of the Frame Group, the VDR should segment the Frame Group into bursts of 62 octets and send a Reservation Request for up to a maximum of 15 slots to the ground station. Transmission of the first segment starts in the first data slot available after the reservation is granted by the ground station and continues until all segments have been transmitted.

A12.4.11.1 Downlink Transmission Confirmation

The VDR sends a UNITDATA.confirm with the flag set to "transmission in progress" when it sends the first segment and a UNITDATA.confirm with the flag set to "transmission completed" when all segments have been transmitted. A single UNITDATA.confirm is sent when the Frame Group is transmitted in a single burst. The CMU starts its re-transmission timer T1 when it receives the UNITDATA.confirm with the flag set to "transmission completed".

The UNITDATA.request message also contains a sequence number used to explicitly correlate UNITDATA.request messages and UNITDATA.confirm messages. It is the responsibility of the CMU to correctly assign sequence numbers. The CMU should manage the sequence number assignment to ensure that each Frame Group sent to the VDR has a unique value. UNITDATA.requests containing re-transmissions of the same Frame Group must use a different sequence number.

COMMENTARY

> ***It is recommended (but not required) that the Frame Group sequence number assignment monotonically increase without gaps then wrap around to 1. The VDR may check the sequence numbers for uniqueness and report duplicates using the VDR_ERROR.indication primitive.***

A12.4.11.2 Downlink Transmission Flow Control

The VDLM3 data service air/ground protocol requires transmission of one Frame Group at a time. When a Frame Group contains one or more INFO or CTRL_RSP Frames which require acknowledgement by the ground, the CMU is responsible for ensuring that no other Frame Group is delivered to the VDR before a DLS ACK Frame has been received or the re-transmission timer T1 has expired.

If the VDR receives a UNITDATA.request before it has completed transmission of a Frame Group, it should discard the UNITDATA.request and send a UNITDATA.confirm to the CMU with the flag set to "discarded frame group".

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

A12.4.12 Uplink Message Handling

All frames that are received in a Frame Group and which meet the screening requirements of Section A12.4.12.1, should be sent to the CMU as a UNITDATA.indication message within 100 milliseconds of the reception of the last bit of the last data burst.

A12.4.12.1 FCS/Address Screening

Each frame in a received Frame Group should contain a 24-bit FCS/Address field and a 3-bit Address Type filed. The FCS/Address field is set to the exclusive OR addition of the Aircraft Station address and the FCS computed over the entire length of the Frame. Before a received frame can be sent to the CMU, its Address field should match the Aircraft's ICAO Address if the Address Type field is 000 (ground-to-air discretely addressed frame) or should be all 1's if the Address Type is 111 (ground-to-air broadcast). The exclusive OR addition of the address and the FCS computed by the VDR should match the FCS/Address in the received frame.

Table A12-4 displays a generic frame format.

A12.4.12.2 Acknowledgement of Received Frame Group

If a received Frame Group contains one or more INFO frames and/or CTRL_RSP frames whose Address matches the aircraft's ICAO Address and all of these frames pass the FCS check, the VDR should send a M burst acknowledgement to the ground station in the next MAC Cycle.

If any of the INFO or CTRL_RSP frames fail the FCS/Address screening, then all INFO and CTRL_RSP frames should be discarded, as the acknowledgement sent to the ground is a group acknowledgement. ACK frames, CTR_CMD and INFO frames with Broadcast Address which pass the FCS/address screening should be delivered.

A12.4.12.3 Stripping of FCS Address

The FCS should be stripped from those frames that pass the screening and are delivered to the CMU; that is, the FCS/Address field of the frames delivered to the CMU should consist only of the aircraft's ICAO Address or Broadcast Address.

A12.4.12.4 Signal Quality Parameter Reporting

Each UNITDATA.indication should include a Signal Quality Parameter (SQP). The SQP value should be determined from the RF signal strength using the following formula:

[TBD -- SQP definition is on the VDL SC agenda.]

The signal strength measurement should be accurate to ±7 dB and be monotonic.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

A12.4.13 Net Release

The VDR can log off the VDLM3 for multiple reasons:

1) Ground initiated – upon receipt of a Terminate Net message from the VDLM3 ground station.
2) VDR initiated -- when out of range of the VDLM3 ground station.
3) Operator initiated -- upon receipt of a retune command from the RTP.
4) CMU initiated -- upon receipt of a Enter Net request message from the CMU.

A12.4.13.1 Ground Initiated Net Release

When the VDR receives a Terminate Net message from the VDLM3 ground station while the CMU/VDR interface protocol is in the DLS_ON state, the VDR should send a Left_Net.indication to the CMU, and the CMU/VDR interface protocol should transition to the PROTOCOL_RESET state.

A12.4.13.2 VDR Initiated Net Release

If the VDLM3 air/ground protocol transitions out of timing state TS1 (VDR stops receiving uplink M bursts from the VDLM3 ground station) while the CMU/VDR interface protocol is in the DLS_ON state, the VDR should send a LEFT_NET.indication to the CMU, and the CMU/VDR interface protocol should transition to the PROTOCOL_RESET state.

A12.4.13.3 Operator Initiated

When the VDR receives a new channel tuning command from the RTP, the VDR should send a Leaving Net message to the VDLM3 ground station. If the CMU/VDR interface protocol is in the DLS_ON state, the VDR should then send a LEFT_NET.indication message to the CMU, and the CMU/VDR interface protocol should transition to the PROTOCOL_RESET state.

A12.4.13.4 CMU Initiated

If the CMU detects an improper recovery at the end of a Ground-Initiated Recovery process (Section A12.4.14), it sends an ENTER_NET.request message to the VDR.

When the VDR has received ENTER_NET.request from the CMU, the VDR should respond with the LEFT_NET.indication message and should initiate the Net Entry process (Section A12.4.6); and the CMU/VDR interface protocol should transition to the PROTOCOL_RESET sub-state of CMD.

A12.4.14 Air/Ground Protocol Error Handling and Recovery

If the VDLM3 ground station determines that it has lost track of Aircraft ID assignments, it sends Recovery M bursts until it has rebuilt its table of Local ID/ICAO Address associations. The VDR

should send a RECOVERY.indication message to the CMU as soon as it receives the initial Recovery M burst from the ground station.

The CMU should respond with a RECOVERY.request message within 240 ms of receipt of the RECOVERY.indication. The RECOVERY.request message should include a CTRL_RSP Frame containing a Network Initialization XID parameter and an Expedited Recovery XID parameter.

The VDR should queue the CTRL_RSP frame until it is granted a slot reservation in a Recovery message from the ground station. The VDR should then transmit the CTRL_RSP frame in the reserved slot.

After having received a RECOVERY.indication message, if the VDR receives an uplink M burst that is not a Recovery message, it should send a RECOVERY.confirm message to the CMU.

The CMU should halt any further downlink transmissions until it receives the RECOVERY.confirm message from the VDR followed by a UNITDATA.indication containing a CTRL_CMD_LPM Frame with Connection Check XID containing a proper Local ID/ICAO Address association. Otherwise, if the Connection Check XID does not contain the expected Local ID/ICAO Address association, the CMU should send an ENTER_NET.request message to the VDR.

A12.4.15 VDR-CMU Interface Error Handling and Recovery

If the CMU determines by examination of the ARINC 429 Label 270 Status Words that the VDR is operating in VDLM3 and that the VDR-CMU Interface is in an unknown or incorrect state, the CMU can return the VDR-CMU interface to a known state as follows.

The CMU can return the VDR to the PROTOCOL_NULL sub-state by sending a MODE_SET.request message (see Section 5.3.2.5, and transition "a" of Figure A12-2). When the MODE_SET.request message is received and the VDR state is CMD then the VDR should transition to the PROTOCOL_NULL state of CMD. When the MODE_SET.request message is received and the VDR state is not CMD, then the VDR should ignore it.

The CMU can return the VDR to the PROTOCOL_RESET sub-state by sending a PR_SET.request message requesting the V3SIP interface protocol (Section 5.3.2.1 and transition (b) of Figure A12-2). The VDR should transition to the PROTOCOL_RESET substate when the PR_SET.request message requesting the V3SIP protocol is received. The VDR should transition to the PROTOCOL_NULL sub-state when the PR_SET.request message containing an unsupported protocol is received. (See Section 5.3.2.1 and transition (d) of Figure A12-2.)

The MODE_SET.request and PR_SET.request messages are sent using the command and control mechanism defined in Section 5.

The VDR can send a VDR_ERROR.indication message to the CMU, and the CMU can send a CMU_ERROR.indication message to the VDR, as the result of various protocol-specific error conditions that may occur. The content of the error message provides an error code as well as an

octet for an error data field. If the error occurred as the result of processing a received primitive, (due to bad data length, for example) the error data field should contain the PID of the offending primitive (as currently defined). These error primitives are valid while the CMU/VDR interface protocol is in the PROTOCOL_RESET, PROTOCOL_SET, and DLS_ON substates of CMD.

A12.4.16 VDR Transmit Buffer Purging

If the VDR's transmit buffer contains a Frame Group whose transmission has not started and the VDR receives a PURGE.request, then the VDR should discard the Frame Group. The VDR should send a UNITDATA.confirm whose Transmit Status field is set to "frame group discarded" (See Section A12.5.12.)

If the VDR's transmit buffer contains a Frame Group whose transmission has not started and the VDR receives a MODE_SET.request, PR_SET.request, or a ENTER_NET.request message, then the VDR should discard the Frame Group. The VDR should send a UNITDATA.confirm whose Transmit Status field is set to "frame group discarded" (See Section A12.5.12.)

A12.4.17 Vendor Reserved Primitives

A set of sixteen primitives are reserved and may be assigned by a manufacturer for purposes outside the scope of this definition. Some of the primitives have been set aside per vendor requests for specific functions unique to those vendors. These reserved primitive ID values should be used only by the vendor that they are assigned to (see Section A12.5.22). These purposes may include, but are not limited to debugging and special test modes. These Extended BOP file primitives of undefined type (COMMAND or DATA), include the ID codes $F0_h$ through FF_h.

A12.5 V3SIP Primitives

The following V3SIP primitives are defined:

Parameter Name	*Subsection*	*Valid States*	*Resultant Substate*
UNITDATA.request	*A12.5.1*	*DLS_ON*	*unchanged*
UNITDATA.indication	*A12.5.2*	*DLS_ON*	*unchanged*
UNITDATA.confirm	*A12.5.3*	*DLS_ON*	*unchanged*
PURGE.request	*A12.5.4*	*DLS_ON*	*unchanged*
RECOVERY.request	*A12.5.5*	*DLS_ON*	*unchanged*
RECOVERY.confirm	*A12.5.6*	*DLS_ON*	*unchanged*
RECOVERY.indication	*A12.5.7*	*DLS_ON*	*unchanged*
ENTER_NET.request	*A12.5.8*	*DLS_ON*	*unchanged*
LEFT_NET.indication	*A12.5.11*	*DLS_ON*	*PROTOCOL_RESET*
DLS_ON.request	*A12.5.12*	*PROTOCOL_SET*	*unchanged*
DLS_ON.confirm	*A12.5.13*	*PROTOCOL_SET*	*DLS_ON*
DLS_OFF.request	*A12.5.14*	*DLS_ON*	*unchanged*
DLS_OFF.confirm	*A12.5.15*	*DLS_ON*	*PROTOCOL_RESET*
DLS_CONNECTED.indication	*A12.5.16*	*DLS_ON*	*unchanged*
DLS_DISCONNECTED.indication	*A12.5.17*	*DLS_ON*	*unchanged*

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

PARAM.request	***A12.5.18***	***PROTOCOL_RESET, PROTOCOL_SET or DLS_ON***	***unchanged***
PARAM.confirm	***A12.5.19***	***DLS_ON***	***PROTOCOL_RESET, DLS_ON, or unchanged***
ADDR.request	***A12.5.20***	***DLS_ON***	***unchanged***
ADDR.confirm	***A12.5.21***	***DLS_ON***	***unchanged***
CMU_ERROR.indication	***A12.5.22***	***PROTOCOL_RESET, PROTOCOL_SET, or DLS_ON***	***unchanged***
VDR_ERROR.indication	***A12.5.23***	***PROTOCOL_RESET, PROTOCOL_SET, or DLS_ON***	***unchanged***
Vendor Reserved Primitives	***A12.5.24***	***vendor defined***	***vendor defined***

The primitives that are transferred between VDR and CMU are used for all command and data transfer, and are of three generic types:

REQUEST ***The REQUEST primitive is passed between the VDR and CMU when a response may be required. Primitives of this type have the form XXX.request.***

CONFIRM ***The CONFIRM primitive is passed between the VDR and CMU in response to a previous REQUEST primitive. Primitives of this type have the form XXX.confirm.***

INDICATION ***The INDICATION primitive is passed between the VDR and the CMU to convey unsolicited information. Primitives of this type have the form XXX.indication.***

The general format of all messages exchanged using the Extended BOP file transfer between the CMU and VDR is as defined in Section 5.1.3.1. For primitives composed of Extended SOLO words, the format is as defined in Section 5.1.3.2.

A12.5.1 Message UNITDATA.request

The CMU uses the UNITDATA.request message to send a VDLM3 data to the VDR. This message contains one Frame Group consisting of one or more Frames to be transmitted by the VDR in the next available transmission.

Message Format

The message consists of one Extended BOP file of type DATA containing the following:

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

Octet	*Parameters*	*Value or Range*
1	*EGFI*	*F3h = V3SIP*
2	*Primitive ID*	*21h = UNITDATA.request*
3	*Data field length MSB*	*The maximum data field length is 933*
4	*Data field length LSB*	*The minimum data field length is 10*
5	*Sequence number*	*0 to FFh (0 to 255)*
6	*Priority*	*0 to 03h (0 to 3)*
7	*Acknowledge Flag*	*00h = unacknowledged downlink*
		01h = acknowledged downlink
8	*Data field byte #1*	*First byte of Frame Group*
9	*Data field byte #2*	*Second byte of Frame Group*
.	.	
.	.	
.	.	
N+7	*Data field byte #N*	*Last byte of Frame Group*

Normal response

UNITDATA.confirm containing the frame group sequence number when transmission starts and is completed or when the frame group is discarded.

Error response

In the event that the VDR detects an error in the data contained in the message, it sends a VDR_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the DLS_ON sub-state of state CMD.

New State

The resulting state is unchanged.

A12.5.2 Message UNITDATA.indication

The VDR uses the UNITDATA.indication message to send VDLM3 data to the CMU. This message contains one Frame Group consisting of one or more received Frames addressed to the aircraft.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

Message Format

The message consists of one Extended BOP file of type DATA containing the following:

Octet	*Parameters*	*Value or Range*
1	*EGFI*	*F3h = V3SIP*
2	*Primitive ID*	*51h = UNITDATA.indication*
3	*Data field length MSB*	*The maximum data field length is 933*
4	*Data field length LSB*	*The minimum data field length is 10*
5	*VDLM3 Frequency MSB*	*(tens, ones of freq. in MHz)* *18 to 36 (12h to 24h) for 118 through 136 MHz.*
6	*VDLM3 Frequency LSB*	*(tenths, hundredths of freq. in MHz, ignore 1000ths)* *00 to 97 (00h to 61h) for xxx.000 through xxx.975 MHz.* *Example: freq = 121.772* *MSB = 21 = 15h* *LSB = 77 = 4Dh (ignore thousandths place)*
7	*Signal Quality Parameter SQP*	*00h to 0Fh; 00h = lowest quality; 0Fh = highest quality*
8	*Data field byte #1*	*First byte of Frame Group.*
9	*Data field byte #2*	*Second byte of Frame Group*
.	.	
.	.	
.	.	
N+7	*Data field byte #N*	*Last byte of Frame Group*

Normal response

None.

Error response

In the event that the CMU detects an error in the data contained in the message, it sends a CMU_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the DLS_ON sub-state of state CMD.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

New State

The resulting state is unchanged.

A12.5.3 Message UNITDATA.confirm

The VDR sends the UNITDATA.confirm to indicate when transmission of a Frame Group has been completed or when a Frame Group is discarded.

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet	*Parameters*	*Value or Range*
1	*EGFI*	*F3h = V3SIP*
2	*Primitive ID*	*56h = UNITDATA.confirm*
3	*Data field length MSB*	*00h*
4	*Data field length LSB*	*02h*
5	*Transmit Status*	*00h = Frame Group transmission completed* *01h = Frame Group discarded*
6	*sequence number*	*0h to FF h (0 to 255)*

Normal response

None.

Error response

In the event that the CMU detects an error in the data contained in the message, it sends a CMU_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the DLS_ON sub-state of state CMD.

New State

The resulting state is unchanged.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

A12.5.4 Message PURGE.request

The CMU sends the PURGE.request to command the VDR to discard the data in a previous UNITDATA.request. The VDR discards the data only if downlink transmission of the data has not started.

Message Format

The message consists of an Extended SOLO word containing the following:

Bit	*Definition*	*Value or Range*
32	*Parity*	
31-29	*Type*	*"101b" = SOLO word*
28-25	*ID*	*"Fh" = Extended SOLO word*
24-21	*EID*	*"3h" = V3SIP*
20-17	*Primitive ID*	*"2h" = PURGE.request*
16-09		*all bits set to zero*
08-01	*SAL*	

Parameters

None.

Normal response

If, as a result of this command, the VDR purges a Frame Group from its transmit buffer, then the VDR sends a UNITDATA.confirm message with Transmit Status set to 01h (discarded) and the sequence number set equal to the sequence number of the discarded Frame Group.

Error response

None.

Reasons for failure

None.

State

This message is processed in the DLS_ON sub-state of state CMD.

New State

The resulting state is unchanged.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

A12.5.5 Message RECOVERY.request

The CMU sends the RECOVERY.request message to the VDR in response to receipt of a RECOVERY.indication message from the VDR. The RECOVERY.request message contains a downlink CTRL_RSP Frame with Expedited Recovery XID and Network Initialization XID data to be sent to the VDLM3 ground station when the VDR is granted a data slot reservation in the M-Recovery burst message from the VDLM3 ground station.

Message Format

The message consists of one Extended BOP file of type DATA containing the following:

Octet	*Parameters*	*Value or Range*
1	*EGFI*	*F3h = V3SIP*
2	*Primitive ID*	*24h = RECOVERY.request*
3	*Data field length MSB*	*00h*
4	*Data field length LSB*	*10h to 65h*
5	*Sequence number*	*0 to FFh (0 to 255)*
6	*Priority*	*03h*
7	*Acknowledge Flag*	*01h = acknowledged downlink*
8	*Data field byte #1*	*First byte of frame.*
9	*Data field byte #2*	*Second byte of frame*
.	.	
.	.	
.	.	
N+7	*Data field byte #N*	*Last byte of frame*

Normal response

RECOVERY.confirm containing the frame sequence number when transmission is completed or when the frame is discarded.

Error response

In the event that the VDR detects an error in the data contained in the message, it sends a VDR_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the DLS_ON sub-state of state CMD.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

New State

The resulting state is unchanged.

A12.5.6 Message RECOVERY.indication

The VDR sends the RECOVERY.indication message to notify the CMU that the ground station is in a Recovery process and provide the CMU with Expedited Recovery parameter data that the CMU needs to include in the CTRL_RSP Frame embedded in the RECOVERY.request.

Message Format

The message consists of an Extended SOLO word containing the following:

Bit	*Definition*	*Value or Range*
32	*Parity*	
31-29	*Type*	*"101b" = SOLO word*
28-25	*ID*	*"Fh" = Extended SOLO word*
24-21	*EID*	*"3h" = V3SIP*
20-17	*Primitive ID*	*"Ah" = RECOVERY.indication*
16-13	*# of pending data segments*	*"0h" to "Fh" (0 to 15)*
12-09	*Priority of data*	*"0h" to "3h" (0 to 3)*
08-01	*SAL*	

Normal response

The CMU should respond to this message with a RECOVERY.request message within 240 ms.

Error response

In the event that the CMU detects an error in the data contained in the message, it sends a CMU_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the DLS_ON sub-state of state CMD.

New State

The resulting state is unchanged.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

A12.5.7 Message RECOVERY.confirm

The VDR sends the RECOVERY.confirm to indicate when the VDLM3 ground station has completed its Recovery process. A Transmit Status parameter indicates whether the CTRL_RSP Frame was transmitted or discarded prior to completion of the Recovery process.

Message Format

The message consists of an Extended SOLO word containing the following:

Bit	*Definition*	*Value or Range*
32	*Parity*	
31-29	*Type*	*"101b" = SOLO word*
28-25	*ID*	*"Fh" = Extended SOLO word*
24-21	*EID*	*"3h" = V3SIP*
20-17	*Primitive ID*	*"Bh" = RECOVERY.confirm*
16-09	*Transmit Status*	*"00h" = Recovery data transmission completed,* *"01h" = Recovery data discarded*
08-01	*SAL*	

Normal response

None.

Error response

In the event that the CMU detects an error in the data contained in the message, it sends a CMU_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the DLS_ON sub-state of state CMD.

New State

The resulting state is unchanged.

A12.5.8 Message ENTER–NET.request

The CMU sends the ENTER_NET.request to command the VDR to perform net re-entry.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

Message Format

The message consists of an Extended SOLO word containing the following:

Bit	***Definition***	***Value or Range***
32	***Parity***	
31-29	***Type***	***"101b" = SOLO word***
28-25	***ID***	***"Fh" = Extended SOLO word***
24-21	***EID***	***"3h" = V3SIP***
20-17	***Primitive ID***	***"1h" = ENTER_NET.request***
16-09	***Data***	***all bits set to zero***
08-01	***SAL***	

Parameters

None.

Normal response

The VDR responds with a LEFT_NET.indication and purges any outstanding untransmitted frames.

If, as a result of this command, the VDR purges a Frame Group from its transmit buffer, then the VDR sends a UNITDATA.confirm message with Transmit Status set to 01h (discarded) and the sequence number set equal to the sequence number of the discarded Frame Group.

Error response

None.

Reasons for failure

None.

State

This message is processed in the DLS_ON substate of state CMD.

New State

The resulting state is PROTOCOL_RESET sub-state of state CMD.

A12.5.9 [Reserved]

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

A12.5.10 [Reserved]

A12.5.11 Message LEFT–NET.indication

The VDR sends the LEFT_NET.indication message to indicate that the VDR has left the VDLM3 net. This message includes the VDLM3 net parameters.

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet	*Parameters*	*Value or Range*
1	*EGFI*	*F3h = V3SIP*
2	*Primitive ID*	*55h = LEFT_NET.indication*
3	*Data field length MSB*	*00h*
4	*Data field length LSB*	*04h*
5	*VDLM3 frequency MSB*	*(tens, ones of freq. in MHz) 18 to 36 (12h to 24h) for 118 through 136 MHz.*
6	*VDLM3 frequency LSB*	*(tenths, hundredths of freq. in MHz, ignore 1000ths) 00 to 97 (00h to 61h) for xxx.000 through xxx.975 MHz.* *Example: freq derived from tuning word = 121.775* *MSB = 21 = 15h (ignore 100's MHz digit)* *LSB = 77 = 4Dh (ignore thousandths place)*
7	*VDLM3 Tuning Slot*	*01h = slot A; 02h = slot B; 03h = Slot C; 04h = Slot D* *00h and 05h-FFh = invalid*
8	*VDLM3 System Configuration*	*00h = 4V(no data services);01h = 3S(no data services)* *02h = 3V1D; 03h = 2V2D; 04h = reserved (3T);* *05h = 3V (no data services); 06h = 2V1D;* *07h = 2S1X (no data services); 08h = 1V3D* *09h-0Fh = reserved; 10h-FFh = invalid*

Normal response

None.

Error response

In the event that the CMU detects an error in the data contained in the message, it sends a CMU_ERROR.indication message.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the DLS_ON sub-state of state CMD.

New State

The resulting state is PROTOCOL_RESET sub-state of state CMD.

A12.5.12 Message DLS_ON.request

The CMU sends the DLS_ON.request to command the VDR to enable uplink and downlink data processing.

Message Format

The message consists of an Extended SOLO word containing the following:

Bit	*Definition*	*Value or Range*
32	*Parity*	
31-29	*Type*	*"101b" = SOLO word*
28-25	*ID*	*"Fh" = Extended SOLO word*
24-21	*EID*	*"3h" = V3SIP*
20-18	*Primitive ID*	*"0h" = DLS_ON.request*
17-09		*all bits set to zero*
08-01	*SAL*	

Parameters

None.

Normal response

The VDR sends a DLS_ON.confirm.

Error response

None.

Reasons for failure

None.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

State

This message is processed in the PROTOCOL_SET sub-state of state CMD.

New State

The resulting state is unchanged.

A12.5.13 Message DLS_ON.confirm

The VDR sends the DLS_ON.confirm to acknowledge reception of the DLS_ON.request message from the CMU.

Message Format

The message consists of an Extended SOLO word containing the following:

Bit	*Definition*	*Value or Range*
32	*Parity*	
31-29	*Type*	*"101b" = SOLO word*
28-25	*ID*	*"Fh" = Extended SOLO word*
24-21	*EID*	*"3h" = V3SIP*
20-17	*Primitive ID*	*"8h" = DLS_ON.confirm*
16-09	*Success*	*"01h" = Enable*
		"0h0" = Disabled
08-01	*SAL*	

Parameters

Data Enabled	*Set to "01h" if the VDR is logged in to a net that supports data link operation at the time that the DLS_ON.reqeust was received. Set to "00h" otherwise.*

Normal response

None.

Error response

None.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

Reasons for failure

None.

State

This message is processed in the PROTOCOL_SET sub-state of state CMD.

New State

The resulting state is DLS_ON sub-state of state CMD.

A12.5.14 Message DLS_OFF Request

The CMU sends the DLS_OFF.request to command the VDR to disable uplink and downlink data processing.

Message Format

The message consists of an Extended SOLO word containing the following:

Bit	*Definition*	*Value or Range*
32	*Parity*	
31-29	*Type*	*"101b" = SOLO word*
28-25	*ID*	*"Fh" = Extended SOLO word*
24-21	*EID*	*"3h" = V3SIP*
20-17	*Primitive ID*	*"6h" = DLS_OFF.request*
16-09	*all bits set to zero*	
08-01	*SAL*	

Parameters

None.

Normal response

The VDR sends a DLS_OFF.confirm.

Error response

None.

Reasons for failure

None.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

State

This message is processed in the DLS_ON sub-state of state CMD.

New State

The resulting state is unchanged

A12.5.15 Message DLS_OFF.confirm

The VDR sends the DLS_OFF.confirm to acknowledge reception of the DLS_OFF.request message from the CMU.

Message Format

The message consists of an Extended SOLO word containing the following:

Bit	*Definition*	*Value or Range*
32	*Parity*	
31-29	*Type*	*"101b" = SOLO word*
28-25	*ID*	*"Fh" = Extended SOLO word*
24-21	*EID*	*"3h" = V3SIP*
20-17	*Primitive ID*	*"9h" = DLS_OFF.confirm*
16-09	*all bits set to zero*	
08-01	*SAL*	

Parameters

None.

Normal response

None.

Error response

None.

Reasons for failure

None.

State

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

This message is processed in the DLS_ON sub-state of state CMD.

New State

The resulting state is PROTOCOL_SET sub-state of state CMD.

A12.5.16 Message DLS–CONNECTED.indication

The CMU sends the DLS_CONNECTED.indication message to indicate successful link negotiation with the VDLM3 net and to provide any non-default MAC and LME parameters negotiated.

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet	*Parameters*	*Value or Range*
1	*EGFI*	*F3h = V3SIP*
2	*Primitive ID*	*25h = DLS_CONNECTED.indication*
3	*Data field length MSB*	*00h*
4	*Data field length LSB*	*13h (19 decimal)*
5	*Non-default parameters flag*	*00h = use default values; 01h = use new values*
6	*NM1*	*0 = no new value; 1 to 128 = new value to use*
7	*RR MSB*	*0 = no new value;*
8	*RR LSB*	*1 to 256 = new value to use*
9	*WR MSB*	*0 = no new value;*
10	*WR LSB*	*1 to 256 = new value to use*
11	*RE MSB*	*0 = no new value;*
12	*RE LSB*	*1 to 256 = new value to use*
13	*RL MSB*	*0 = no new value;*
14	*RL LSB*	*1 to 256 = new value to use*
15	*NL1*	*0 = no new value; 1 to 128 = new value to use*
16	*TL4 MSB*	*0 = no new value;*
17	*TL4 LSB*	*1 to 300 = new value to use*
18	*WE MSB*	*0 = no new value;*
19	*WE LSB*	*1 to 256 = new value to use*
20	*t (time to truncation) MSB*	*0 = no new value;*
21	*t LSB*	*1 to 256 = new value to use*
22	*f (time to free-running) MSB*	*0 = no new value;*
23	*f LSB*	*1 to 256 = new value to use*

Normal response

None.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

Error response

In the event that the VDR detects an error in the data contained in the message, it sends a VDR_ERROR.indication. An unsupported parameter should not trigger a VDR_ERROR.indication.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the DLS_ON sub-state of state CMD.

New State

The resulting state is unchanged.

A12.5.17 Message DLS–DISCONNECTED.indication

The CMU sends the DLS_DISCONNECTED.indication to notify the VDR that the CMU was unable to negotiate a suitable data link network connection with the ground.

Message Format

The message consists of an Extended SOLO word containing the following:

Bit	*Definition*	*Value or Range*
32	*Parity*	
31-29	*Type*	*"101b" = SOLO word*
28-25	*ID*	*"Fh" = Extended SOLO word*
24-21	*EID*	*"3h" = V3SIP*
20-17	*Primitive ID*	*"4h" = DLS_DISCONNECTED.indication*
16-09		*all bits set to zero*
08-01	*SAL*	

Parameters

None.

Normal response

None.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

Error response

None.

Reasons for failure

None.

State

This message is processed in the DLS_ON sub-states of state CMD.

New State

The resulting state is unchanged.

A12.5.18 Message PARAM.request

The CMU sends the PARAM.request message to request Net Entry and MAC and LME operating parameters in use.

Message Format

The message consists of an Extended SOLO word containing the following:

Bit	*Definition*	*Value or Range*
32	*Parity*	
31-29	*Type*	*"101b" = SOLO word*
28-25	*ID*	*"Fh" = Extended SOLO word*
24-21	*EID*	*"3h" = V3SIP*
20-17	*Primitive ID*	*"2h" = PARAM.request*
16-09	*Data*	*all bits set to zero*
08-01	*SAL*	

Parameters

None.

Normal response

The VDR responds to this message with a PARAM.confirm message containing the VDR's active VDLM3 Net Entry parameters and active MAC and LME parameter values.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

Error response

In the event that the VDR detects an error in the data contained in the message, it sends a VDR_ERROR.indication message. An unsupported parameter value should not trigger a VDR_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_RESET, PROTOCOL_SET and DLS_ON substates of state CMD.

New State

The resulting state is unchanged.

A12.5.19 Message PARAM.confirm

The VDR sends the PARAM.confirm message in response to a PARAM.request message. It contains the VDR's current operational parameters. If the PARAM.request message was received while the VDR was not logged in a net, then the VDLM3 System Configuration parameter should be set to FFh and other parameters should be considered by the CMU as irrelevant or invalid. Otherwise, if the VDR was logged in a net, the parameters should be set to the current net operational parameters.

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet	*Parameters*	*Value or Range*
1	*EGFI*	*F3h = V3SIP*
2	*Primitive ID*	*50h = PARAM.confirm*
3	*Data field length MSB*	*00h*
4	*Data field length LSB*	*1Eh (27 decimal)*
5	*VDLM3 frequency MSB*	*(tens, ones of MHz) 18 to 36 (12h to 24h) for 118 through 136 MHz.*
6	*VDLM3 frequency LSB*	*(tenths, hundredths of freq. in MHz, ignore 1000ths) 00 to 97 (00h to 61h) for xxx.000 through xxx.975 MHz.* *Example: freq derived from tuning word = 121.775* *MSB = 21 = 15h (ignore 100's MHz digit)*

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

		LSB = 77 = 4Dh (ignore thousandths digit)
7	*VDLM3 Tuning Slot*	*01h = slot A; 02h = slot B; 03h = Slot C; 04h = Slot D 00h and 05h-FFh = invalid*
8	*VDLM3 System Configuration*	*00h = 4V(no data services);01h = 1V3D 02h = 3V1D; 03h = 2V2D; 04h = reserved (3T); 05h = 3V (no data services); 06h = 3S (no data service); 07h = 2S1X (no data services); 08h = 1V2D 09h = 2V1D; 0Ah-0Fh = reserved; 10h-FFh = invalid*
9	*Local ID*	*assigned user group + Aircraft ID*
10	*Link preservation flag*	*00h = no previous link; 01h = previous link preserved*
11	*Signal Quality Parameter SQP*	*00h to 0Fh; 00h = lowest quality; 0Fh = highest quality*
12	*Vocoder algorithm version*	*01h = AMBE-ATC-10; other values reserved/invalid*
13	*VDLM3 Protocol version*	*00h = version 4.0; other values reserved/invalid*
14	*NM1*	*1 to 128 = new value accepted or value in use*
15	*RR MSB*	
16	*RR LSB*	*1 to 256 = new value accepted or value in use*
17	*WR MSB*	
18	*WR LSB*	*1 to 256 = new value accepted or value in use*
19	*RE MSB*	
20	*RE LSB*	*1 to 256 = new value accepted or value in use*
21	*RL MSB*	
22	*RL LSB*	*1 to 256 = new value accepted or value in use*
23	*NL1*	*1 to 128 = new value accepted or value in use*
24	*TL4 MSB*	
25	*TL4 LSB*	*1 to 300 = new value accepted or value in use*
26	*WE MSB*	
27	*WE LSB*	*1 to 256 = new value accepted or value in use*
28	*t (time to truncation) MSB*	
29	*t LSB*	*1 to 256 = new value accepted or value in use*
30	*f (time to free-running) MSB*	
31	*f LSB*	*1 to 256 = new value accepted or value in use*

Normal response

None.

Error response

In the event that the CMU detects an error in the data contained in the message, it sends a CMU_ERROR.indication message.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_RESET, PROTOCOL_SET and DLS_ON sub-states of state CMD.

New State

The resulting state should be PROTOCOL_SET if the PARAM.request was received while in the PROTOCOL_RESET state and the VDR was logged in to a net at the time the PARAM.request was received. The resulting state should remain DLS_ON if the PARAM.request was received while in the DLS_ON state. Otherwise, the resulting state is unchanged.

A.12.5.20 Message ADDR.request

The CMU may send the ADDR.request message to inquire the 24-bit ICAO Address and Broadcast Address being used by the VDR for address screening.

Message Format

The message consists of an Extended SOLO word containing the following:

Bit	*Definition*	*Value or Range*
32	*Parity*	
31-29	*Type*	*"101b" = SOLO word*
28-25	*ID*	*"Fh" = Extended SOLO word*
24-21	*EID*	*"3h" = V3SIP*
20-17	*Primitive ID*	*"5h" = ADDRS.request*
16-09	*Data*	*all bits set to zero*
08-01	*SAL*	

Parameters

None.

Normal response

The VDR should respond with an ADDR.confirm message.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

Error response

In the event that the VDR detects an error in the data contained in the message, it sends a VDR_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the DLS_ON sub-state of state CMD.

New State

The resulting state is unchanged.

A12.5.21 Message ADDR.confirm

The VDR sends the ADDR.confirm message in response to an ADDR.request. It contains the 24-bit ICAO Address and Broadcast Address used by the VDR to screen uplink frames.

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet	*Parameters*	*Value or Range*
1	*EGFI*	*F3h = V3SIP*
2	*Primitive ID*	*52h = ADDR.confirm*
3	*Data field length MSB*	*00h*
4	*Data field length LSB*	*06h*
5	*ICAO Address, octet 1*	*Bit 1 corresponds to bit 1 of the Station Address.*
6	*ICAO Address, octet 2*	*Bit 1 corresponds to bit 9 of the Station Address.*
7	*ICAO Address, octet 3*	*Bit 1 corresponds to bit 17 of the Station Address.*
8	*Broadcast Address, octet 1*	*Bit 1 corresponds to bit 1 of the Station Address.*
9	*Broadcast Address, octet 2*	*Bit 1 corresponds to bit 9 of the Station Address.*
10	*Broadcast Address, octet 3*	*Bit 1 corresponds to bit 17 of the Station Address.*

Normal response

None.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

Error response

In the event that the CMU detects an error in the data contained in the message it sends a VDR_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the DLS_ON sub-state of state CMD.

New State

The resulting state is unchanged.

A12.5.22 Message CMU–ERROR.indication

The CMU sends the CMU_ERROR.indication message to indicate that a protocol error occurred. Protocol errors can include the reception of a message out of sequence for the current state, an unrecognized primitive, or a format error in the message.

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet	*Parameters*	*Value or Range*
1	*EGFI*	*F3h = V3SIP*
2	*Primitive ID*	*23h = CMU_ERROR.indication*
3	*Data field length MSB*	*00h*
4	*Data field length LSB*	*02h*
5	*Error code*	*See Table A12-3*
6	*Error data*	*See Table A12-3*

Normal response

None.

Error response

In the event that the VDR detects an error in the data contained in the message, it sends a VDR_ERROR.indication message.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

Reasons for failure

BADDATA - data length invalid or otherwise in error.

State

This message is processed in the PROTOCOL_RESET, PROTOCOL_SET, and DLS_ON substates of state CMD.

New State

The resulting state is unchanged.

A12.5.23 Message VDR_ERROR.indication

The VDR sends the VDR_ERROR.indication message to indicate that a protocol error has occurred. Protocol errors can include the reception of a message out of sequence for the current state, an unrecognized primitive, or a format error in the message or VDR transmit buffer overflows (CMU sends frame when buffer is full).

Message Format

The message consists of one Extended BOP file of type COMMAND containing the following:

Octet	*Parameters*	*Value or Range*
1	*EGFI*	*F1h*
2	*Primitive ID*	*53h*
3	*Data field length MSB*	*00h*
4	*Data field length LSB*	*02h*
5	*Error code*	*See Table A12-3*
6	*Error data*	*See Table A12-3*

Normal response

None.

Error response

In the event that the CMU detects an error in the data contained in the message, it sends a CMU_ERROR.indication message.

Reasons for failure

BADDATA - data length invalid or otherwise in error.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

State

This message is processed in the PROTOCOL_RESET, PROTOCOL_SET, and DLS_ON sub-states of state CMD.

New State

The resulting state is unchanged.

A12.5.24 Vendor Reserved Primitives

Certain primitives are reserved for use by manufacturers for diagnostic, debugging or other purposes. An Extended BOP file primitive whose Primitive ID falls within the range $F0_h$ to FF_h is considered to be a vendor-reserved primitive. The type (COMMAND or DATA) of these reserved primitives is undefined.

COMMENTARY

Some vendors have expressed a desire for a dedicated Vendor reserved primitive and have been assigned a primitive ID value. Only the vendor that has been assigned that primitive ID value should use it. A vendor that desires to have a primitive ID value assigned should contact the AEEC VDL Subcommittee Secretary. The following primitive ID values have been assigned:

F0h – Honeywell
F1h – Rockwell Collins

Message Format

The message consists of one Extended BOP file of type COMMAND or DATA containing the following:

Octet	*Parameters*	*Value or Range*	*Note*
1	*EGFI*	*F3h*	*Indicates V3SIP*
2	*Primitive ID*	*F0h to FFh*	*Range of vendor primitives*
3	*Data field length MSB*	*-*	
4	*Data field length LSB*	*-*	
5	*Data Field Byte #1*		
6	*Data Field Byte #2*		
.	*.*		
.	*.*		
.	*.*		
N+4	*Data Field Byte #N*		

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

Normal response

Vendor defined.

Error response

Vendor defined.

State

Vendor defined.

New State

Vendor defined.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

Table A12-1 VDR-CMU Functional Allocations

VDLM3 Protocol Layer	*Functionality Allocated to VDR*	*Functionality Allocated to CMU/ATSU*
Physical Layer	• ***All functionality***	***none***
MAC Sub-layer	• ***All functionality***	***none***

LME Sub-layer	• ***Frequency tuning control***
	• ***Net Initialization***
	• ***Net Entry***
	• ***Link Maintenance***
	  • ***Poll response***
	  • ***Dummy poll response***
	• ***Recovery***
	  • ***M- Recovery response Voice only and Voice/Data configurations***
	• ***Link Release & handoff***
	  • ***Explicit & Implicit***
	• ***Urgent Downlink request***
		• ***DLS Connection Establishment (i.e., Link Initialization)***
		• ***Link (XID parameter) modification***
		• ***Authentication***
		• ***Recovery verification & XID processing***
		• ***Make-before-Break Operation***
		• ***Join/Leave Event Notification to upper layers***

DLS Sub-layer	• ***D/L Frame Group segmentation*** • ***U/L Frame Group re-assembly*** • ***U/L Frame ungrouping*** • ***U/L Frame FCS/Address screening*** • ***U/L Frame FCS removal*** • ***Acknowledgement of U/L Frames***	• ***D/L Frame formatting*** • ***D/L Frame re-transmission*** • ***D/L Frame queuing & prioritization*** • ***D/L Frame grouping*** • ***U/L Frame duplicate detection & discard*** • ***U/L ACK processing***
Subnetwork Layer	***None***	***All including:*** • ***ISO 8208 compression and/or*** • ***CLNP compression***
SNDCF	***None***	***All functionality***
Voice Vocoder	***All functionality***	***none***

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

Table A12-2 VDR-CMU V3SIP Primitives

Command/Query Message	*Primitive*	*Sender*	*Primitive ID*	*Type*
Downlink data transfer	*UNITDATA.request*	*CMU*	21_h	*DATA*
CMU Error indication	*CMU_ERROR.indication*	*CMU*	23_h	*COMMAND*
Recovery data transfer	*RECOVERY.request*	*CMU*	24_h	*DATA*
Notification of connection	*DLS_CONNECTED.indication*	*CMU*	25_h	*COMMAND*
Enable data transfer	*DLS_ON.request*	*CMU*	0_h	*Ext. SOLO*
Command net entry	*ENTER_NET.request*	*CMU*	1_h	*Ext. SOLO*
Op parameter request	*PARAM.request*	*CMU*	2_h	*Ext. SOLO*
Purge request	*PURGE.request*	*CMU*	3_h	*Ext. SOLO*
Disconnection indication	*DLS_DISCONNECTED.indication*	*CMU*	4_h	*Ext. SOLO*
Address request	*ADDR.request*	*CMU*	5_h	*Ext. SOLO*
Disable data transfer	*DLS_OFF.request*	*CMU*	6_h	*Ext. SOLO*
Op parameter acknowledge	*PARAM.confirm*	*VDR*	50_h	*COMMAND*
Uplink data transfer	*UNITDATA.indication*	*VDR*	51_h	*DATA*
Address acknowledgment	*ADDR.confirm*	*VDR*	52_h	*COMMAND*
VDR Error indication	*VDR_ERROR.indication*	*VDR*	53_h	*COMMAND*
Net exit notification	*LEFT_NET.indication*	*VDR*	55_h	*COMMAND*
Frame transmission confirm	*UNITDATA.confirm*	*VDR*	56_h	*COMMAND*
Data transfer enabled	*DLS_ON.confirm*	*VDR*	8_h	*Ext. SOLO*
Data transfer disabled	*DLS_OFF.confirm*	*VDR*	9_h	*Ext. SOLO*
Recovery notification	*RECOVERY.indication*	*VDR*	A_h	*Ext. SOLO*
Recovery completion	*RECOVERY.confirm*	*VDR*	B_h	*Ext. SOLO*
Vendor Reserved Primitives	*Vendor defined*	*VDR/CMU*	$F0_h$ *to* FF_h	*COMMAND or DATA*

Note: All primitives are composed of Extended BOP files except as indicated.

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

Table A12-3 Error Messages

Error Condition	*Sender*	*Error Code*	*Error Data*
Unspecified Error	*CMU/VDR*	00_h	*Don't care*
Unrecognized PID	*CMU/VDR*	01_h	*Offending PID*
BADDATA	*CMU/VDR*	02_h	*Offending PID*
VDR transmit buffer overflow	*VDR*	03_h	*None*
Out of sequence or unexpected primitive	*CMU/VDR*	04_h	*Offending PID*

Table A12-4 Generic VDLM3 DLS Frame Format

		Bit Number							
	Octet #	*8*	*7*	*6*	*5*	*4*	*3*	*2*	*1*
FCS/Address Field	*1*	*24*	*23*					*18*	*17*
	2	*16*	*Aircraft Address XOR 24-bit FCS*						*9*
	3	*8*	*7*					*2*	*1*
Link Control	*4*	*Frame Type/Priority*			*MF*	*T*	*Address Type*		
Data Control 1	*5*	*DL [MSB]*	*Ground Subnetwork Address*						
Data Control 2	*6*	*Data length (DL) [LSB]*							
Information	*7 ...N+6*	*User Data*							

Table A12-5 Address Type Field Encoding

Bit Encoding			*Description Type*	*Comments*
3	*2*	*1*		
0	*0*	*0*	*ground-to-specified aircraft*	*24-bit ICAO address*
0	*0*	*1*	*specified aircraft-to-ground*	*24-bit ICAO address*
0	*1*	*0*	*Undefined*	*Future Use*
0	*1*	*1*	*Undefined*	*Future Use*
1	*0*	*0*	*Undefined*	*Future Use*
1	*0*	*1*	*Undefined*	*Future Use*
1	*1*	*0*	*Undefined*	*Future Use*
1	*1*	*1*	*ground-to-air broadcast*	*All 1's address*

ATTACHMENT 12 (cont'd)
VDL MODE 3 SIMPLE INTERFACE PROTOCOL (V3SIP)

ATTACHMENT 13
VDL MODE 3 CONFIGURATION DESCRIPTIONS

The VDL Mode 3 architecture provides the flexibility to accommodate a range of operational requirements through a set of predefined system configurations. In the Air Traffic Control (ATC) environment the airspace is divided into distinct sectors. All the users in a sector form a user group and maintain a degree of mutual connectivity. A user group normally includes a ground user (e.g., an air traffic controller) and the client aircraft of that ground user. The services provided to a particular user group depend on the requirements of the sector and the capabilities of the ground system.

To meet the required degree of flexibility, different configurations provide differing mixes of voice and/or data capabilities. At any given time different sectors can be supported by differing configurations, and the configuration that applies in a particular sector is communicated to the aircraft radios through a beacon signal that is periodically broadcast by the ground station(s). It is expected that the configuration that applies to any given sector will be quasistatic and will not change often.

There are 4-slot configurations and 3-slot configurations. The 4-slot configurations provide guard time sufficient to allow interference-free communication for up to 200 nautical miles (NM). For longer range scenarios, the 3-slot configurations can be used. Each of the configurations occupies one or more time slots available within one 25 kHz frequency assignment. In the descriptions below, the phrase "independent voice and data" means that uplink or downlink voice communication and uplink or downlink data communication can be occurring simultaneously on a single platform with no mutual interference.

The 4-slot configurations are:

4V *Provides a voice channel using 1 of the 4 time slots for each user group. A data capability is not provided. Can support up to 60 addressed aircraft per user group.*

2V2D *Provides independent voice and data channels using one dedicated time slot for voice and one dedicated time slot for data for each user group. Can support up to 60 addressed aircraft per user group.*

3V1D *Provides independent voice and data channels using one dedicated time slot for voice for each of the three user groups and a time slot shared by up to three of the user groups for data. Can support up to 60 addressed aircraft per user group.*

1V3D *Provides independent voice and data using one time slot for voice and three time slots for data by a single user group. This is used to support sectors with more than 60 users that also require real-time voice service. Can support up to 240 addressed aircraft in one (large) user group.*

The 3-slot configurations are:

ATTACHMENT 13 (cont'd)
VDL MODE 3 CONFIGURATION DESCRIPTIONS

3V ***Provides a voice channel using 1 of the 3 time slots for each user group. A data capability is not provided. Can support up to 60 addressed aircraft per user group.***

2V1D ***Provides independent voice and data channels using one dedicated time slot for voice for each of the two user groups and a time slot shared by up to two of the user groups for data. Can support up to 60 addressed aircraft per user group.***

3S ***Provides a single voice channel using all (3) time slots. A data capability is not provided. This is used to support very large sectors in which three ground stations are required to provide complete coverage. Can support up to 60 addressed aircraft for the user group.***

2S1X ***Provides a single voice channel using 2 of the 3 time slots for one user group. The third time slot can be used to provide an independent channel for another user group. A data capability is not provided. This is used to support very large sectors in which two ground stations are required to provide complete coverage. Can support up to 60 addressed aircraft per user group.***

1V2D ***Provides independent voice and data using one time slot for voice and two time slots for data by a single user group. This is used to support sectors with more than 60 users that also require real-time voice service. Can support up to 240 addressed aircraft in one (large) user group.***

COMMENTARY

Overlapping sectors can use different configurations on the same 25 kHz frequency assignment provided that: (1) they all use either 3-slot or 4-slot configurations, (2) they do not use the same time slots, and (3) they are geographically compact enough so that time slot boundaries are not violated. For example, a 2V2D sector using slots A and C can be collocated with a 4V sector using slot B and another 4V sector using slot D.

APPENDIX A
TERMS ***AND CONVENTIONS***

Basic Voice Service	***A domain of VDLM3 Voice operation that essentially emulates the operational "feel" of VHF DSB-AM voice to the crew; available to all VDLM3 avionics from all VDLM3 ground stations. Certain VDLM3-specific features are available in Basic Voice Service; e.g., Transmit Status Indication, Service Level Status indication and Controller Override.***
Channel	***A discrete information-bearing component of the VDLM3 signal in space at a given tuning Frequency. Depending on the mode of operation, a Frequency may support multiple Channels which can be individually selected.***
Enhanced Voice Service	***A domain of VDLM3 Voice operation that provides advanced features of digital voice communications such as Next Channel Uplink and Urgent Downlink Request. It is automatically enabled in VDLM3 avionics when the VDR is logged-in to a VDLM3 net and the ground station supports it.***
Frequency	***A specific assigned portion of the aeronautical VHF communications RF band, which portion can be individually selected.***
Logged-in Status	***[TBD for other operational modes, as applicable.]*** ***In VDLM3 operation, the VDR's status is "Logged-in" when it maintains communications with ground station with which it has established a Net Entry condition using a valid ICAO Address (see Section 3.7.1). If the VDR is Logged-in, it can support Enhanced Voice and Data Services; otherwise, it supports only Basic Voice Service.***
Necessary Bandwidth	***For a given class of emission, the width of the frequency band which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions.***
Out-of-band Emission	***Emission on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious emissions.***

CONVENTIONS

In this document bytes are called octets and are numbered, from right (least significant bit) to left (most significant bit), 1 to 8 (e.g., $_{MSB}8765\ 4321_{LSB}$).

APPENDIX B
ACRONYMS

ACARS	Aircraft Communications Addressing and Reporting System
ACARSIP	***ACARS Simple Interface Protocol***
ACK	Acknowledge
AEEC	Airline Electronic Engineering Committee
AIM	***Aeronautical Information Manual***
AM	Amplitude Modulation
AMCP	Aeronautical Mobile Communications Panel
AMS	***Audio Management System***
AMS(R)S	***Aeronautical Mobile-Satellite (Route) Service***
ARINC	Aeronautical Radio Incorporated
ASIP	AVLC Simple Interface Protocol
ATE	Automatic Test Equipment
AVLC	Aviation VHF Link Control
BCS	Block Check Sequence
BER	Bit Error Rate
BITE	Built-In Test Equipment
BOP	Bit-Oriented Protocol
BP	Bottom Plug
CFDIU	Centralized Fault Display Interface Unit
CFDS	Centralized Fault Display System
CMC	Central Maintenance Computer
CMU	Communications Management Unit
[C]MU	***Indicates either a Management Unit or a Communications Management Unit, as appropriate***
CRC	Cyclical Redundancy Check
COMM	Communications
CTS	Clear-To-Send
CU	Channel Utilization
D8PSK	Differential Eight-Phase Shift Keyed
DAS	Destination Address Set
dB	decibel
dBc	***decibels with respect to the carrier.***
dBm	decibels referenced to 1 milliwatt
dBW	decibels referenced to 1 watt
dc	direct current
DFS	Digital Frequency Select
DITS	Digital Information Transfer System
DLS	Data Link Service
DRB	Download Request Bit
DSB-AM	Double-Sideband Amplitude Modulation (classic VHF analog modulation)
ECAC	Electromagnetic Compatibility Analysis Center
EGFI	Extended GFI
EID	Extended ID
EMI	Electromagnetic Interference
FCC	Federal Communications Commission
FCS	Frame Check Sequence
FEC	Forward Error Correction
FM	Frequency Modulated
GFI	General Format Identifier
GNSS	***Global Navigation Satellite System (e.g., GPS and GLONASS)***
GPS	***Global Positioning System***
ICAO	International Civil Aviation Organization
ID	Identification
I/O	Input/Output
I/P	Internetworking Protocol
ISO	International Standards Organization
kHz	kiloHertz

APPENDIX B (cont'd)
ACRONYMS

LDU	Link Data Unit
LME	Link Management Entity
LRU	Line Replaceable Unit
MAC	Media Access Control
MASPS	***Minimum Aviation System Performace Standards***
LSB	Least Significant Bit
MHz	MegaHertz
MODEM	Modulator/Demodulator
MOPS	***Minimum Operational Performance Standards***
MP	Middle Plug
msec	***milliseconds***
MSK	Minimum Shift Keying
MSB	Most Significant Bit
MU	Management Unit
MUX	Multiplexer
N/A	Not Applicable
NCD	No Computed Data
NCTS	Not-Clear-To-Send
NIC	New Installation Concepts
nm	nautical mile
OMS	Onboard Maintenance System
OSI	***Open-System Interconnect (a model of layered protocols standardized by ISO)***
PA	Power Amplifier
PIC	***Protocol Identifier Code***
PID	Primitive Identifier
ppm	***parts per million***
pps	***pulses per second***
PSB	Protocol Status Bit
PTT	Push-to-Talk
RACK	***Request Acknowledgment***
RCV	Receive
RF	Radio Frequency
RR	Receive Ready Frame
RTP	***Radio Tuning Panel***
RTS	Ready-To-Send
SAL	System Address Label
SARPs	Standards and Recommended Practices
SDI	Source/Destination Identifier
SELCAL	Selective Calling
SSM	***Signed Status Matrix***
SOT	Start of Transmission
SREJ	Selective Reject
SQP	Signal Quality Parameter
SSM	Sign Status Matrix
SYS	System
TBD	To Be Determined
TDMA	***Time Division Multiple Access***
TP	Top Plug
TSO	Technical Standard Order
UDR	***Urgent Downlink Request***
V3SIP	***VDLM3 Simple Interface Protocol***
Vdc	Volts direct current
VDL	VHF Digital Link
VDR	VHF Digital Radio
VHF	Very High Frequency
VSWR	Voltage Standing Wave Ratio
W	Watt

APPENDIX C
BIBLIOGRAPHY

The following documents are referenced in this Characteristic. Designers should be aware that many of these documents are in the continuing process of being supplemented.

Aeronautical Information Manual, FAA

ARINC Specification 404A, "Air Transport Equipment Cases and Racking"

ARINC Report 413A, "Guidance for Aircraft Electrical Power Utilization and Transient Protection"

ARINC Specification 429, "Mark 33 Digital Information Transfer System (DITS)"

ARINC Characteristic 597, "Aircraft Communications Addressing and Reporting System (ACARS)"

ARINC Specification 600, "Air Transport Avionics Equipment Interfaces"

ARINC Report 604, "Guidance for Design and Use of Built-In Test Equipment (BITE)"

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ARINC Specification 615, "Airborne Computer High Speed Data Loader"

ARINC Specification 618, "Air-Ground Character-Oriented Protocol Specification"

ARINC Specification 619, "ACARS Protocols for Avionic End Systems"

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ARINC Report 624, "Design Guidance for Onboard Maintenance System"

ARINC Specification 626, "Standard ATLAS for Modular Test"

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ARINC Specification 637P1, "Aeronautical Telecommunications Network (ATN): Implementation Provisions, Part 1, Protocols And Services"

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ARINC Characteristic 718, "Mark 3 Air Traffic Control Transponder (ATCRBS/MODE S)"

ARINC Characteristic 724, "Mark 2 Aircraft Communications Addressing and Reporting System (ACARS)"

ARINC Characteristic 724B, "Aircraft Communications Addressing and Reporting System (ACARS)"

ARINC Characteristic 758, "Communications Management Unit (CMU) Mark-2"

ICAO Annex 10, Volume III, Part I -- Digital Data Communication Systems, Chapter 6, VHF Digital Link (Note: Latest amendment is in preparation)

ICAO Doc 4444, PANS-RAC

ICAO Document XXXX, Manual of Technical Specifications for VHF Digital Link Mode 2 (Note: This document is in preparation and is not yet numbered.)

ICAO Document YYYY, Manual of Technical Specifications for VHF Digital Link Mode 3 (Note: This document is in preparation and is not yet numbered.)

APPENDIX C (cont'd)
BIBLIOGRAPHY

ICAO Document ZZZZ, Manual on VHF Digital Link Mode 3 Implementation Aspects (Note: This document is in preparation and is not yet numbered.)

RTCA Document DO-160C, "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments".

RTCA Document DO-207, "Minimum Operational Performance Standards for Devices that Prevent Blocked Channels used in Two-Way Radio Communications Due to Unintentional Transmissions".

RTCA Document DO-224A, "Signal-In-Space Minimum Aviation Systems Performance Standards (MASPS) for Advanced VHF Digital Data Communications Including Compatibility with Digital Voice Techniques"

RTCA Document DO-271A, "MOPS for Aircraft VDL Mode 3 Transceiver Operating in the Range 117.975-137.000 MHz"

RTCA Document DO-279, "Next Generation Air/Ground Communications (NEXCOM) Principles of Operation, VDL Mode 3"

RTCA Document DO-281, "MOPS for Aircraft VDL Mode 2 Transceiver Operating in the Range 117.975-137.000 MHz"

Specification 63Z, "VHF Digital Link Mode 3 Implementation Provisions" (Note: This document does not yet exist. As ARINC Specification 631 addresses only VDL Mode 2, it is anticipated that an equivalent document will be developed for VDL Mode 3 Data operations.)